GOLDEN JUBILEE YEAR

VOL. 99 FEBRUARY, 1934 No. 2

ANNALS of SURGERY

A Monthly Review of
Surgical Science and Practice

Edited by

LEWIS STEPHEN PILCHER, M.D., LL.D., of New York

Associate Editors

W. SAMPSON HANDLEY, M.S., M.D., F.R.C.S., of London
JAMES TAFT PILCHER, B.A., M.D., of New York
WALTER ESTELL LEE, M.D., of Philadelphia

Official Publication of the American Surgical Association, of the New York Surgical Society and the Philadelphia Academy of Surgery

CONTENTS

J. B. LIPPINCOTT COMPANY

SPINAL ANESTHESIA

A RECORD OF SAFETY

Seventeen years without a death —either on the operating table or during the postoperative critical period—is the record of Dr. Gaston Labat, using NEOcaine for Spinal Anesthesia.

Dr. Harry Koster, who has performed more than 7000 major operations under Spinal Anesthesia with NEOcaine, prefers this anesthetic because of its greater safety and convenience.

With technical skill and clinical judgment, similar results can be achieved by other trained men. But always remember that substitutes for NEOcaine are more toxic.

NEOcaine is the pure French product, packed in ampoules in the U. S. A. The spinal fluid is allowed to drop directly into the ampoule, dissolving the crystals, and then reinjected. In boxes of 10 ampoules, of 0.05, 0.08, 0.10, 0.12, 0.15, 0.20 and 0.30 Gm. each.

NEOCAINE

MOTION PICTURE FILMS

illustrating

Technique of Spinal Anesthesia

These educational films will be loaned, without charge, to hospitals and other responsible institutions. For further information, write to Medical Department, Anglo-French Drug Co. (U. S. A.), Inc., 1270 Broadway, New York, N. Y.

ANGLO-FRENCH DRUG CO. (U. S. A.), Inc.

1270 Broadway, New York, N. Y.

ANNALS *of* SURGERY

Vol. 99 FEBRUARY, 1934 No. 2

THE USE OF FASCIA IN RECONSTRUCTIVE SURGERY *

WITH SPECIAL REFERENCE TO OPERATIVE TECHNIC

By Charles Murray Gratz, M.D.

of New York, N. Y.

McArthur,[1] in 1901, transplanted fascial tissues for the repair of hernia. Since that date, other clinicians have contributed largely to the clinical and experimental work in this field.[2] Patch transplants were commonly used by the earlier workers and many difficulties were encountered in the securing of permanent viability. Gallie and Le Mesurier[3] definitely improved the technic by using fibrous tissue in the form of a suture and they also devised special needles. The introduction of these transplants in the form of sutures reduced the dependence previously necessary on the development of scar tissue alone and hence increased the strength of the transplant and enhanced their viability.

Living sutures of fascial material have been successfully used in many branches of surgery. In gynecology they have been used in the correction of various displacements of the uterus; for the repair of the perineum and cervix; for correction of pleural defects in thoracic surgery and also for the repair of dural defects. In abdominal surgery they have proved successful in the treatment of visceroptosis and in the surgery of the hollow viscera. One of the largest fields in which they are now extensively used is in the repair of the various types of hernia. In plastic surgery fascial sutures have been of aid in the correction of facial paralysis and in congenital tosis of the eyelids as well as in many other deformities. In reconstructive surgery of the bones and joints they have proved their value in replacing torn ligaments, correcting chronic dislocations, reconstructing crucial ligaments and replacing tendons. They have been used in connecting muscles to tendons, including such large tendons as the biceps, hamstrings, quadriceps and tendon Achilles; in tenodesis; in replacing annular ligaments; in the repair of joint capsules; the early reduction of fractures and as a supplement to plastic bone work. In the form of large transplants they have proved invaluable in the reconstruction of joints by arthroplasty.

The fundamental difference between living sutures and prepared ones (either absorbable or non-absorbable), is that the former take an active part in the desired union of the tissues in contra-distinction to the passive rôle of the prepared suture. The time of absorption of the prepared sutures has

* Presented before the Society for Plastic and Reconstructive Surgery, October 29, 1932.

been found to be variable and they may be absorbed before the desired union of the tissues has taken place with the resultant failure of the operation. This has been frequently found in muscle and tendon work and is particularly the case when absorbable sutures are used in plastic bone surgery. If the sutures are absorbed before there is sufficient callus formation to hold the fragments in place, the muscle pull may result in displacement of the fragments. Delayed absorption, on the other hand, may result in the sutures acting as a foreign body and in their extrusion. Non-absorbable suture material has a tendency to cut out and set up irritation with the resultant danger to the patient. Autogenous sutures, if properly used, not only are free from these disadvantages but have the important advantage—viability. As a result, the strength and elasticity remain unimpaired and they increase the strength of the union besides taking an active part in it. It is now generally accepted that they will grow solidly to bone, muscle and fascia if properly coaptated.

Fascial material is composed of parallel bundles of wavy bands of elastic material, with a fine but scanty tissue stroma binding them together and covered by a connective tissue of rather delicate and loose texture which blends into the surrounding tissues. A liberal supply of blood and lymph permeates the structures.

It is important to remember that transplanted living sutures rely on their nourishment in the host tissues, not on blood but on the lymphatic supply. If any structure is allowed to separate the host and the scion tissue, the death of the transplanted tissue may ensue. This makes it necessary to remove all fat and areolar tissue before transplantation. Trauma to the transplant is to be avoided. The transplanted should be under proper tension with the bone, muscle or fibrous tissue with which it comes in contact. If it is too large or if it is inserted in the form of a tube, the central portion may receive an inadequate supply of lymph and its vitality will be endangered. The fascia unites to its host tissue by means of scar tissue. If the suture tissue is so placed that the entire strain is borne by it, the time necessary for immobilization is much less than if we rely on the scar tissue alone.

When living sutures are used intra-articularly, they are exposed to the synovial fluid of the joints, and the fate of these sutures is of interest. Research along this line is as yet scanty.

In using living sutures an accurate knowledge of their strength and elasticity is of value in determining the size of the suture required and also is of assistance in guiding our technic. In 1930,[4] the tensile strength and elasticity of human fascia lata were studied with engineering accuracy. Summarizing the results very briefly, the material showed great tensile strength, comparing favorably with soft steel wire of the same weight. It also showed a high degree of elasticity. The maximum tensile strength of the test pieces was 7,860 pounds per square inch. By plotting graphs from test of several specimens it was possible to estimate a safe stress which these tissues would stand without endangering their viability. Taking an average

thickness the breaking tension of a strip of this material three-eighths inches wide is about fifty-five pounds. The optimum load which could safely be applied to such a strip should not exceed sixteen pounds. When it is thought that the load requirement may be in excess of the above, a multiple suture should be used. When a suture is tied in a loop it is equivalent to a single suture of double strength. This work also showed that fascia lata if used within safe stress showed an elasticity of 91 per cent. This high elasticity is an additional factor in promoting accuracy and more favorable results with living sutures.

In planning the operative technic the surgeon should remember that living fibrous tissue is of a soft and slippery nature and is much more difficult to

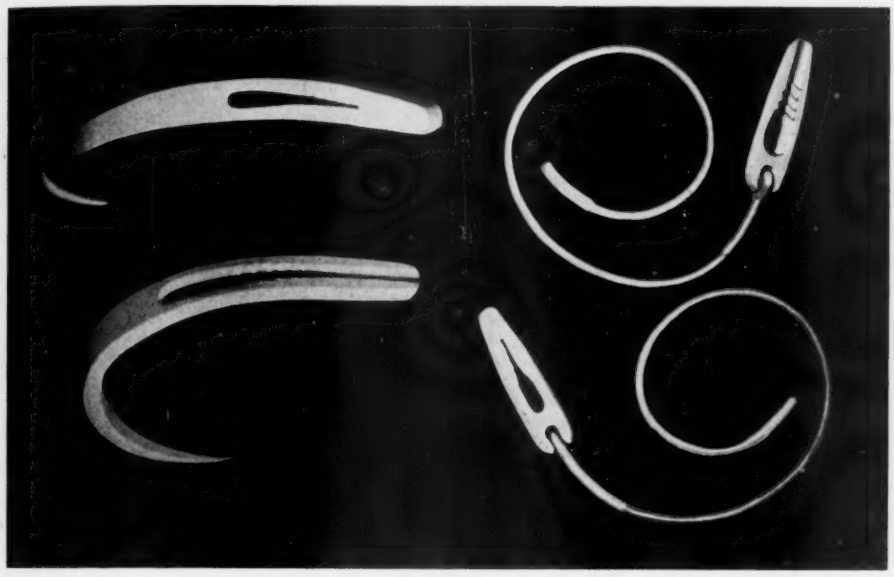


FIG. 1.—Fascia needle for use in soft tissues.
FIG. 2.—Suture threader for fascial suture introduction in osseous tissue.

handle than other sutures. To facilitate the use of these sutures in soft tissues, Gallie improved the old-type surgical needle by sufficiently enlarging the eye to accommodate it to the size of the suture. Lane and Austin[5] added a small loop of wire about one inch in length to the heel of the ordinary needle and threaded the fascia through this loop. Both these needles require overtying the suture to prevent unthreading. There was also bunching in the eye. Both factors increased suture trauma and necessitated a longer suture due to the overtying. In order to further reduce suture trauma and facilitate the introduction and working of these sutures, two new instruments were devised,[6] one used in the soft tissues (Fig. 1) and a suture carrier for use in osseous structures (Fig. 2). The eye in both these instruments is formed as an elongated wedge with the thin end toward the heel of the needle. The posterior half of the eye is finished with sloping teeth,

the anterior portion remaining smooth. This type of eye permits the insertion of the living material edgewise at the larger anterior end and when tension is applied to the suture it is drawn down to the thin edge of the wedge and securely held in place. This type of eye permits threading of the needle with a minimum waste of suture, holds the suture with a maximum of firmness and entirely eliminates the necessity of overtying. For soft tissues a curved cutting edge needle is used and for osseous tissues a suture carrier was devised with a long flexible leader. This leader may easily be pushed through the drill holes and its flexibility permits the surgeon to insert the suture even if the holes are imperfectly aligned, or are difficult of access.

The flexible leader of the new suture carrier reduces the amount of traction necessary for its insertion, hence a smaller incision may be frequently used. The size of the drill holes need be only slightly greater than the size of the suture carrier. If the drilled holes are not perfectly aligned it may be necessary to make them slightly larger so that the threader will pass without difficulty. When a suture is being placed through the joint it is important to keep the articular edges in firm apposition so that no bone chips enter the joint which may act as foreign bodies and result in damage to the joint later. This is easily accomplished by manual pressure. If a transverse fracture is being sutured, it is better mechanically to place the sutures through the holes in the opposite cortex rather than using the through-and-through suture. This gives better mechanical fixation. All the sutures should be so placed that they will give a maximum correction of the muscle pull which tends to cause an over-riding. The periosteum itself is left in place until the suture is fastened to it. This additional anchorage of the suture gives greater opportunity for the formation of fibrous connective tissue, hence increasing suture viability.

After the holes have been prepared the suture is taken from the saline-moistened gauze, a clamp is placed on the free end grasping a minimum amount of suture, the latter threaded through the holes and the suture thus introduced. A second suture may be placed through the same holes. In certain cases it will be of advantage to use two suture carriers at the same time. An absorbable suture is often placed through the same holes which takes the additional stress until such times as the living suture becomes firmly imbedded in its new position and new fibrous tissue has formed around it.

If the suture be securely anchored at the periphery the main body will of necessity be more securely fastened throughout its entire length and if of the correct size, accurate and firm coaptation throughout its entire length will be assured. In anchoring a loop suture a square knot is used, both parts of which are partially overtied with either an absorbable or autogenous suture. The latter suture does not go through the entire living suture but includes up to half of its diameter. In this way there is no danger of inter-

fering with the viability. In anchoring the free end of the suture in the bony structure a single or double knot is tied and the free ends and the knot itself are sewed to the periosteum. In certain cases a second drill hole is made to anchor the suture and adjust the tension. The muscle and soft tissues are sewed in the ordinary manner and drainage is never used.

The entire technic is so devised as to place the entire physiological strain on the suture itself and the osseous structures. If the sutures are tied by absorbable ones alone the suture is weakened. The time of immobilization depends directly on the strength of the internal fixation. In the upper extremity it is possible to start passive motion as early as one week post-operative. Living sutures may also be used to supplement the technic for bone grafts and bone pegs as they have greater resistance to trauma. There is little danger of their being torn by the sharp edges of bone and their viability enhances union between the transplanted and host tissues.

CONCLUSIONS.—(1) The operative technic of fascial transplantation is based primarily on the study of the physiology of these tissues.

(2) Fascial sutures will grow solidly to bone, muscle and fascia *if properly coaptated*, and will live in these host tissues indefinitely.

(3) The technic herein described has proved clinically to conform with the above requirements.

(4) The new instruments have proved of value in simplifying the operative work.

(5) Research work for the study of tensile strength and elasticity of fascia has been of value in aiding the determination of the proper choice and size of suture best suited for the individual case.

(6) The technic is so devised that the entire stress is borne by the suture itself without relying on the strength of scar tissue. This has permitted earlier mobilization.

BIBLIOGRAPHY

[1] McArthur, L. L.: Autoplastic Suture in Hernia and Other Diastases. Jour. Am. Med. Assn., vol. xxxvii, p. 1162, November, 1901.

[2] Kirschner (quoted from Neuhof): Uber freie Sehnen aus Fasciatransplantation. Beitr. z. klin. Chir., vol. lxii, p. 539, 1909.

[3] Gallie, W. E., and Le Mesurier, A. N.: The Use of Living Sutures in Operative Surgery. Canad. Med. Assn. Jour., vol. xi, pp. 504–513, 1921.

[4] Tensile Strength and Elasticity Tests on Human Fascia Lata. Jour. Bone and Joint Surg., vol. xiii, No. 2, pp. 334–340, April, 1931.

[5] Lane, T. J. D., and Austin, T. A.: Three New Instruments for Obtaining and Working Fascial Sutures. The Lancet, p. 622, March 22, 1930.

[6] New Instruments for Living Sutures. Am. Jour. of Surg., new series, vol. xiii, No. 1, pp. 81–82, July, 1931.

THE REACTION OF THE RETROPERITONEAL TISSUES TO INFECTION

By Harold I. Meyer, M.D.

of Chicago, Ill.

from the department of surgery, of the university of illinois

In the practice of surgery, one is impressed with the difference in reaction of the body to infections lying in and about the abdomen, following rupture of visci, cholecystitis, appendicitis, pelvis infections and others. He notes that in some cases peritonitis develops, which may be localized or become generalized, usually followed by death. In other cases, there is no violent reaction which accompanies generalized peritonitis, but symptoms and signs of abscess formation are discovered. These abscesses may be successfully dealt with surgically, but only too frequently death follows, due to these abscesses and their sequelæ, septicæmia, pyæmia, pylephlebitis, subdiaphragmatic abscesses, *etc.*

Anyone not familiar with the literature, dealing with the vast amount of experimental work on the reactions of the peritoneum to infections, has himself observed that it has great protective powers. He may also have observed that patients do not so frequently recover from abscesses lying deep in the abdomen.

Believing that the retroperitoneal tissues did not have this special resistive power to infection, in common with the peritoneum, and unable to find an account of any experimental work dealing with this subject, the writer endeavored to ascertain what the reaction of the retroperitoneal tissues to infection would be.

The accompanying studies of the reactions of the peritoneum to infections were made only by way of comparison to the reactions of the retroperitoneal tissues, because exhaustive studies on the peritoneum have been made, serologically, bacteriologically, histologically, and the few peritoneal reactions noted in this work are exceedingly superficial in comparison to the work already done. Our problem is primarily to determine the end-results, whether or not infections of the retroperitoneal tissues carry a higher mortality than infections of the peritoneum.

Much experimental work has been done by Wegner, Chaveau, Gravitz, and others, to show that the peritoneum can overcome bacteria without the development of peritonitis and under what conditions exudation and peritonitis do occur. Wegner was the first to study the reactions of the peritoneum in a comprehensive way. He demonstrated that the peritoneum absorbed with impunity a considerable quantity of putrefying material. He also showed that if such material in sufficient amounts could be introduced, death by intoxication might result before the defensive functions of the peritoneum could be mobilized.

If, for any reason, absorption of nonfatal doses was delayed, time might be had for the bacteria to multiply and the peritoneum thus become the site of a

rapidly developing colony. Here we find clearly set forth several fundamental factors: the possibility of death by the absorption of toxins before reactive factors could be set into action, that is, before peritonitis could develop; that small doses of bacteria might be destroyed before they could do harm; also, that stagnating fluid in the peritoneal cavity would favor the development of bacteria.

Much research followed that tended to obscure rather than clarify the real problems. Chaveau repeated Wegner's experiments using micrococcus septicus, and he determined that the animals died from absorption of septic products without any obvious changes in the peritoneum. Gravitz presented another phase of Wegner's work. He noted that when bacteria were introduced, suspended in fluid that was absorbed in a few hours, infection did not follow, but if the fluid stagnated peritonitis developed. The processes of absorption and exudation of the peritoneum will not be considered in this work, but a knowledge of these processes should be clearly in mind in order to properly understand the subject of peritonitis.

Dogs varying from seven to ten kilograms were subjected to laparotomy under ether anæsthesia. Two types of organisms were used, *Staphylococcus aureus* and *Bacillus pyocyaneus*, the latter being used in most of the cases, since a virulent culture of it could be gotten. The bacteria grown on plain agar slants were removed by water washings and two cubic centimetres of this suspension were used for the injections.

All but two of the intraperitoneal injections were made at the base of the gall-bladder and those two were made at the base of the appendix. These sites were also used for the retroperitoneal injections, great care being taken not to contaminate the peritoneum in making the retroperitoneal injections. The abdomens were closed. The animals were closely watched for all symptoms, which were recorded as were the temperature readings. Since these temperatures varied so greatly, far out of proportion to the condition of the animals, we found them of little value. The normal temperature of dogs is not constant.

As soon as possible after the animals died, complete autopsies were performed. Those animals, that apparently had recovered from the effects of the injections, were killed after twenty days and complete autopsies performed.

A distinctly different type of clinical reaction was observed in those animals receiving intraperitoneal injections from those receiving retroperitoneal injections. In the first case, the animal within a few hours would become very sick, have a marked rise in temperature, no desire to eat or drink, nausea and vomiting, irritability, diarrhœa in several instances and prostration. The animals that did not die from this acute toxæmia improved fairly rapidly and completely recovered. Of the ten cases having intraperitoneal injections, five died and five recovered, those dying all having been injected with *B. pyocyaneus*.

Those animals having retroperitoneal injections, with two exceptions, did not have an immediate reaction of acute toxæmia, but after an apparent recovery from the operation, began to fail gradually, as shown by loss of appetite, no desire for water, occasional vomiting, increasing diarrhœa, loss of weight,

going on to extreme emaciation and death. Ten of the twelve animals that were injected with *B. pyocyaneus* and one of the three animals injected with *Staphylococcus aureus* died. The two animals having immediate reactions following retroperitoneal injections were thought to have had peritoneal contamination. They did not die as a direct result of these reactions but recovered, only to die later. Autopsies were performed on all the animals soon after death, except in one case, when it was done on the second day. Here the advanced post-mortem changes made observations valueless. Cultures were taken from the lesions found and from the peritoneal cavities.

There were no deaths from intraperitoneal injections except immediate ones, within five days from the time of injection. No abscesses developed in those receiving intraperitoneal injections and no peritonitis developed in any of those cases, as evidenced by loss of glistening surface of the peritoneum or the presence of exudation at the time of the autopsy. Of the five cases that died, three had sterile peritonea, and all those that lived had sterile peritonea at the time they were killed. Those dying of toxæmia consistently showed marked injection of the liver, spleen, pancreas, kidneys and bowel.

Of the three receiving retroperitoneal injections with *Staphylococcus aureus*, one died with multiple abscesses of the liver, the other two living, these showing no post-mortem findings when killed after twenty days.

Of the twelve receiving retroperitoneal injections of *B. pyocyaneus*, ten died, nine of which had abscesses, retroperitoneally, at the site of injection. One which had a retroperitoneal injection died thirty-three days later, but no abscess was found, or any pathological finding which would account for death. It is significant that nine of the twelve animals receiving retroperitoneal injections should develop abscesses, while none of those receiving intraperitoneal injections developed abscesses or even exudation. In all nine of these cases, *B. pyocyaneus* was recovered from the abscesses, and from three of them the organism was recovered from the peritoneal cavity.

No abscesses of the liver were found in any of these cases except from direct extension from the abscess at the site of injection. Neither were there any instances of gall-bladder involvement, thrombosed portal vessels or signs of pylephlebitis. No abscesses were found in any of the other organs.

The heart was examined in all cases, and in one case, where the animal died seven days following injection, in which a large abscess was found at the site of the injection, abundant vegetations of the mitral valves were found. In four other cases, the valve margins showed some proliferations and in two others there were questionable proliferations.

The average length of life of those animals receiving intraperitoneal injections, which died, was 3.6 days, the shortest time being less than one day and the longest five days. The average for those dying after retroperitoneal injections was 11.1 days, the shortest being one day and the longest thirty-three days.

Experimentally, it has been shown that no deaths occurred from intraperitoneal injections except immediate deaths from toxæmia, and in these three

out of five had sterile peritonea, no abscesses developed, and there were no signs of peritonitis. In those receiving retroperitoneal injections, one-third of the cases in which staphylococcus was used developed abscesses, and three-fourths of those in which pyocyaneus was used developed abscesses, all of which died. These facts, we feel, tend to prove that the retroperitoneal tissues are less resistant to the invasion of organisms than is the peritoneum.

CHART

	Staphylococcus 6		Pyocyaneus 19		Totals	
	Intra. 3	Retro. 3	Intra. 7	Retro. 12	Intra. 10	Retro. 15
Abscess	0	1	0	9	0	10
Deaths	0	1	5	10	5	11
Peritonitis	0	0	0	0	0	0
Culture of peritoneum	0	0	2	3	2	3

Days Animals Lived After Injection

Staphylococcus		Pyocyaneus	
Intra.	Retro.	Intra.	Retro.
No. deaths	7	1	1
		3	2
		4	4
		5	4
		5	7
			7
		Av. 3.6	8
			17
			28
			33
			Av. 11.1

These experiments have a direct clinical application to burying of infected stumps such as after cholecystectomy and appendectomy. It is felt that many post-operative abscesses are attributed to this cause, which would not occur should the infected stump be allowed to come into contact with the peritoneum, which can cope with the infection, rather than be buried behind the peritoneum in the retroperitoneal tissues, which do not have this resistive power. This is particularly true of the stump of an infected cystic duct, which is placed in direct contact with a large denuded area.

BIBLIOGRAPHY

Morton, C. B.: Peritoneal Absorption, Comparison between Normal and Inflamed Peritonea. Am. Jour. Med. Sci., vol. clxxiii, pp. 517–523, April, 1927.

Klein, William: Absorption of Toxins from the Peritoneal Cavity. Am. Jour. Surg., vol. xxxix, pp. 56–59.

Bolton, Charles: Absorption from Peritoneal Cavity. Jour. of Path. and Bact., vol. xxiv, pp. 429–445.

Steinberg, B., and Goldblatt, H.: Studies in Peritonitis. Arch. Int. Med., vol. xxxix, pp. 446–455.

Herrman, S. F.: Bacterial Absorption from the Peritoneal Cavity. Proceedings of the Staff Meetings of the Mayo Clinic, vol. iii, May 9, 1928.

Costain, W. A.: Lymphaticostomy in Peritonitis. Surg., Gynec., and Obstet., vol. xxxv, p. 365, March, 1923.

Durham, Herbert: Mechanism of Reaction to Peritoneal Infection. Jour. of Path. and Bact., vol. iv, 1897.

Meltzer, J. S.: On Paths of Absorption from Peritoneal Cavity. Jour. of Physiol., vol. xii, pp. 198–205.

Benions, I. B. C.: Further Experiments with Fixation Areas Bearing on the Pathogenicity of *B. Coli* in Peritoneal Infections. Brit. Exper. Jour., vol. v, pp. 123–127.

THE RATIONALE OF THE TREATMENT OF CHRONIC OSTEOMYELITIS WITH SPECIAL REFERENCE TO MAGGOT THERAPY*

By Joseph Buchman, M.D.

of Brooklyn, N. Y.

FROM THE SERVICES OF DR. SAMUEL KLEINBERG, HOSPITAL FOR JOINT DISEASES, NEW YORK CITY, AND THE ISRAEL ZION HOSPITAL, BROOKLYN, N. Y., AND THE FIRST ORTHOPEDIC DIVISION, HOSPITAL FOR THE RUPTURED AND CRIPPLED, OF NEW YORK, N. Y.

"Once osteomyelitis, always osteomeylitis" expresses the helplessness of the surgeon from time immemorial in the face of osteomyelitis. Rays of sunshine are now beginning to appear, giving rise to reasonable hope that the problem will in a measure be surmounted in the not far-distant future. This is based, first, upon recent accessions to our knowledge of the pathogenesis of acute osteomyelitis and the dawning realization and dissemination of the observations that early diagnosis and prompt and efficient treatment may abort the long series of tragic events known to all of us only too well. The second factor at the basis of this fond hope is dependent upon recent advances in the technic of the care of the chronic forms of this dread affection. We shall limit ourselves in this presentation to a consideration of the rationale of the treatment of chronic osteomyelitis, and a critical comparison of the basic factors involved in the various forms of therapy now in vogue.

The treatment of chronic osteomyelitis has been haphazard up to recent times. The surgical approach varied from extensive excision of bone shafts to mere incision and drainage and removal of sequestra. The problem of filling the resulting bone cavities gave rise to the development of various bony- and soft-tissue plastic operations and the use of various pastes, semi-solid substances, and even plaster-of-Paris. All of these procedures, however, met with little success.

As a result of the World War, three more or less standardized methods of treatment have been evolved, namely: the Carrel-Dakin method, the Orr technic, and Baer's maggot therapy. These procedures with several modifications are now in general use.

Before evaluating these methods, one must pause for a moment to consider the factors underlying chronic osteomyelitis. In the first place, there are disseminated foci of infection and devitalized particles of bone and soft tissue, enclosed by the rigid walled cavities throughout the bones. To eliminate these foci radical bone surgery is essential; indeed, one cannot be too radical. One must, however, respect in so far as possible the epiphyseal plates, the periosteal covering and the circulation of the bone. Once this is obtained by operative interference, one is confronted by a large bone

* Presented before the New Utrecht Medical Society, January 23, 1933.

cavity which must be filled in from the bottom up, by granulation tissue. The second factor underlying this affection is due to the great difficulty encountered in obtaining a satisfactory healing of this cavity. The magnitude of this difficulty is due to unequal healing, resulting in the enclosure of infected foci by the more rapidly forming granulation tissue. Furthermore, it must be appreciated that bone defects heal so slowly that the early formed granulations undergo the changes incidental to scar-tissue formation before the bone cavity becomes entirely filled. It is therefore evident that as cicatrization occurs in the periphery there is a consequential shutting off of the blood supply which stunts further bony growth and prevents complete healing. One may, therefore, be confronted with a possibly well-formed scar tissue at the periphery while in the centre there is a cessation of healing because of an insufficient blood supply. Added to this is the ever-present possibility of re-infection of the indolent tissue in the unhealed portion and lighting up of the enclosed foci previously mentioned.

In view of the above considerations, it appears that the ideal method of treatment of chronic osteomyelitis should have as its basis the following prerequisites: (1) A thorough surgical removal of all diseased parts; (2) some efficient method of sterilization of the surgically formed wound; (3) some method of removal of wound discharges and of the sloughed-off tissues that occur subsequent to operation; and (4) some agent that would produce even and rapid growth from the bottom up, to cause complete filling of the bone cavity before the circulatory changes incidental to scar formation occur.

With these criteria in mind, it is now opportune to examine the effects of the various methods of treatment mentioned above. The Carrel-Dakin, the Orr, and the maggot therapies are all based upon a thorough saucerization of the affected part, that is, a surgical procedure to remove all devitalized bone, overhanging ledges and grossly infected soft tissues. Beyond that, the underlying principles are different.

At the time of the introduction of the Carrel-Dakin method it was thought that the efficacy of the treatment was due to chemical sterilization of the wound. It was subsequently disproved, for inert solutions used with the same minute technic produced the same results. It therefore became evident that the value of the treatment is due to physical removal and possibly chemical solution of the wound discharges. This method, therefore, meets only two of the four criteria proposed for the ideal method of approach to the treatment of chronic osteomyelitis; namely, the thorough surgical removal of all diseased parts and the removal of wound slough and discharges. The results obtained are superior to the previous haphazard methods, but the number of failures of healing and recurrences are great. Furthermore, this method causes great discomfort to the patient and is tedious and time-consuming to both the patient and surgeon.

The Orr technic is based upon a thorough surgical removal of all dis-

eased parts. The vaseline pack acts as an efficient method of drainage. In addition, the physical resistance offered by the pack and the physiological rest incidental to immobilization in plaster-of-Paris aid wound healing which must be spontaneous, for there is no active agent to stimulate growth. The infrequent dressings prevent re-infection, but no efficiently active measure is introduced to sterilize the wound. Subsequent to the introduction of the method it was realized that in accordance with the experiments and theories of D'Herelle and Besredka spontaneous sterilization occurs through the formation of bacteriophages. More recently, Albee has added to this method by attempting to sterilize the wound by the administration of a stock or an autogenous bacteriophage. This method, therefore, meets all of the criteria save the last for there is no provision in this method of treatment for stimulation of growth. Furthermore, sterilization, as the method is commonly used, is spontaneous and therefore haphazard unless the Albee modification is added to the treatment. The application of bacteriophage is not always practicable, because, to be effective, it must be potent and adaptable for the infecting organism. Although there are now a number of phages which are potent for various strains of staphylococcus, there are comparatively few for the streptococcus. It has also been demonstrated that to be effective the phage must be in intimate contact with the diseased part, and that inflammatory exudates, blood serum and blood interfere with its efficacy. The results of this treatment are superior to those of the Carrel-Dakin method. It is more comfortable for the patient, less tedious and time-consuming for the surgeon, but is objectionable because of its offensive odor. There are, however, a considerable number of failures and recurrences and the period of convalescence, though shorter than in the Carrel-Dakin method, is nevertheless prolonged.

The maggot treatment meets all of the above-mentioned criteria. First, there is a thorough surgical removal of the diseased area. Second, the wound is actively sterilized by the maggots which physically remove microörganisms by ingestion. Third, the proteolytic activity of the maggot enzymes breaks down the wound discharges and sloughs into end-products, which are then consumed by the maggots. And fourth, the maggots, in crawling about the wound, irritate it sufficiently to stimulate rapid growth. This factor, the importance of which is great in the proper healing of extensive wounds, is possible only with the use of maggots. The results obtained by this method, though not perfect, are superior to either of the previously mentioned technics, the time consumed in convalescence is considerably reduced and the number of failures and recurrences, in so far as one can judge from observations over several years, are greatly diminished.

A review of the literature on the maggot therapy of chronic osteomyelitis reveals many reports of very high percentages of healing. The period of observation of these healed cases has, it is true, been insufficient to render

final judgment possible, for in no instance has the length of follow-up been over two years. Nevertheless, it is very definite that immediate healing can be obtained in eight to twelve weeks and that recurrences within the period of observation have been unusually few.

Our own experience confirms the above findings. Furthermore, our studies of the character of the healing that occurs under the influence of maggot therapy lead us to believe that in all probability these desirable results will be permanent. We can now reaffirm, and Pomeranz has confirmed the observation that we made in a previous communication, that from the röntgenographical standpoint the healing is very characteristic and highly satisfactory. The affected bones approach the normal in this process of healing in that there is no residual sclerosis or rarefaction, and that the cortices, medullary canals, and metaphyses become reformed and assume a normal appearance. Furthermore, these röntgenographical appearances were confirmed at the operating table. In a number of instances secondary operations were necessary. On each of these occasions we encountered in the healed areas normal-looking bony parts supplied with a rich circulation in contrast to the eburnated or softened areas with deficient blood supply one usually finds in those instances treated by other methods of therapy.

The following two cases are cited to demonstrate the differences in the character of the healing of chronic osteomyelitis treated by the Orr technic and maggot method.

CASE I.—R. T., a white male of fifteen years of age, gave a history on admission to the service of Doctor Finkelstein at the Hospital for Joint Diseases that on July 20, 1931, he was afflicted with a sore throat which was soon thereafter followed by an osteomyelitis of the hip-joint. Four days later pain and swelling appeared in the left forearm. This subsided after several days. Two months thereafter and on several subsequent occasions pain recurred. The patient was admitted on February 15, 1932, and within a few days an operation was performed on the left forearm and the Orr technic was carried out. One month later an abscess ruptured spontaneously and drained for twenty-eight weeks. On August 25, 1932, another acute exacerbation occurred and another operation, a saucerization, was performed, and the Orr treatment was again instituted. On November 23 a two-inch sequestrum was removed, and a stock bacteriophage was introduced into the wound. During the early part of January, 1933, the lesion healed clinically, and has remained so to date. There were other osteomyelitic foci in the right hip and left tibia and fibula which were treated by the Orr method on several occasions, and which are still draining. These need not concern us in this presentation.

Fig. 1, an anteroposterior and lateral view of the left forearm taken prior to the first operation, shows an extensive involvement of the radius as evidenced by numerous areas of rarefaction and condensation, an obliteration of the medullary canal, a loss of clearness of the cortex, and the presence of a periosteal reaction. Fig. 2 represents similar views taken one year later subsequent to three operative interferences, and after the forearm was clinically healed. A study of these röntgenograms shows areas of condensation, areas of rarefaction, obliteration of the medullary canal and indistinctness of the cortex.

It is very evident at a mere glance of the latter pictures that the disease process is still present. The clinical healing cannot possibly be permanent for the areas of rarefaction are indicative of enclosed foci of infected granulation tissue, while the areas of condensation and the obliteration of the medullary canal are indicative of deficient cir-

FIG. 1.

FIG. 2.

FIG. 1.—(Case I.) Showing areas of rarefaction and condensation, an obliteration of the medullary canal, a loss of clearness of the cortex, and a periosteal reaction of the radius.

FIG. 2.—Same patient. One year later, subsequent to three operative interferences (Orr technic), and clinical healing. Showing presence of disease as evidenced by areas of condensation, areas of rarefaction, obliteration of the medullary canal, and indistinctness of the cortex.

culation. Since experience has shown that healing is never permanent unless the bone regains an approximately normal appearance, this case will in all probability be subject to recurrent exacerbations of the osteomyelitic process.

In contrast to Case I we cite Case II, which was subjected to maggot therapy.

CASE II.—A. H., a white male of eleven years of age, was admitted to the service of Dr. Samuel Kleinberg at the Hospital for Joint Diseases because of multiple foci of osteomyelitis involving both tibiæ, the left fibula, the right humerus, and a suppurative arthritis of the right knee complicated by multiple deformities and bed sores. Several months after the original infection the right humerus became involved, as evidenced by pain, swelling, and disability. The pain soon subsided, and recurred thereafter on several occasions over a period of one year during which time no surgical treatment was instituted in so far as the humerus was concerned. On September 4, 1931, the writer performed a saucerization operation and instituted maggot therapy. Seventeen maggot dressings were applied and notwithstanding that on two different occasions the wound was excessively irritated by the maggot applications, the wound healed completely in four months and has remained so ever since. The other foci healed in shorter intervals of time, but they need not concern us here.

Fig. 3, a röntgenographical study of the right humerous just prior to operation, shows an extensive osteomyelitic lesion as indicated by the presence of areas of rarefaction, areas of condensation, thickening of the cortex, periosteal reaction, and a blocking of the medullary canal. Fig. 4 is a similar study fifteen weeks later, just prior to the complete epithelization of the wound. This picture is characterized by an absence of areas of rarefaction and condensation, a complete filling of the saucerized area which was extensive and involved somewhat more than the upper half of the bone, and a beginning reappearance of the medullary canal. The newly deposited bone is smooth and regular in density. Fig. 5 is a röntgenograph of the same humerus made fifteen months subsequent to Fig. 4. The bone is now practically normal in contour, the cortex and medullary canal are well differentiated, and there are no areas of condensation or rarefaction.

One cannot but be impressed with the last röntgenogram and no matter how pessimistic one may be, one cannot but be very hopeful that this area will not be subject to a recurrence of the osteomyelitic process. The healing is so satisfactory and the reconstruction of the bone is so much akin to that following a fracture that optimism is truly justified.

The contrast between the healing process in Case II and that in Case I (compare Figs. 5 and 2) is so marked that comment seems to be superfluous. The result obtained in Case II has been duplicated in the author's experience so frequently and so universally that no matter how critical and unbiased his attitude and that of his associates has been, they all feel the superiority of maggot therapy, notwithstanding its details and tediousness, to other methods of treatment of chronic osteomyelitis.

In view of the data and the many independent reports on hand, it seems justifiable to conclude that the maggot therapy of chronic osteomyelitis has very distinct advantages over other methods of treatment. It is the only method which fulfills all of the essentials necessary for satisfactory healing in that it actually stimulates rapid filling of the wound in addition to sterilizing it and emptying it of discharges and débris. The character of the healed

FIG. 3. FIG. 4. FIG. 5.

FIG. 3.—(Case II.) Right humerus, showing an extensive osteomyelitic lesion as indicated by the presence of areas of rarefaction, areas of condensation, thickening of the cortex, periosteal reaction, and a blocking of the medullary canal.

FIG. 4.—(Case II.) Fifteen weeks after operation and subsequent to maggot therapy and just prior to epithelization of the wound. Showing absence of areas of rarefaction and condensation, complete filling of the saucerized areas and a beginning reappearance of the medullary canal. The newly formed bone is smooth and regular in density.

FIG. 5.—(Case II.) Fifteen months subsequent to Fig. 4, showing practically normal contour of the bone; cortex and medullary canal are well differentiated; no areas of condensation or rarefaction.

bones is more nearly normal than that resulting from any other procedure, for there is no residual sclerosis or rarefaction and there is in addition an actual reformation of the bony parts. The maggot therapy has now gained recognition in many quarters and the resulting accumulation of trustworthy independent observations attest to its efficacy in the treatment of chronic osteomyelitis.

BIBLIOGRAPHY

[1] Albee, F. H.: Will Bacteriophage Prove Ideal in Wound Treatment? Am. Jour. of Surg., vol. xv, p. 228, 1932.

[2] Baer, W. S.: The Treatment of Chronic Osteomyelitis with the Maggot (Larva of the Blowfly). Jour. of Bone and Jour. Surg., vol. xiii, p. 438, 1931.

[3] *Ibid.:* Sacro-iliac Joint; Arthritis Deformans; Viable Antiseptic in Chronic Osteomyelitis. Proceedings International Assembly Inter-State Post-Graduate Medical Association North America, October 21, 25, 1929, vol. v, 1930.

[4] Baer, W. S., and Livingston, S. K.: The Treatment and Cure of the Disease known as Osteomyelitis. Hearings before the Committee on World War Veterans' Legislation, House of Representatives, 71st Congress, 2nd Session, April 17, 1930.

[5] Bauman, G. I., and Campbell, H. E.: Resection of Long Bones for Osteomyelitis. Surg., Gynec. and Obstet., vol. xlii, p. 114, 1926.

[6] Besredka, A.: Immunisation locale, Pansements Specifiques. Masson et Cie., édit, Paris, 1925.

[7] Bick, E.: Manuscript on the History and Source Book of Orthopedic Surgery. In publication by the Hospital for Joint Diseases.

[8] Bishopp, F. C.: Laake, E. W., and Parman, D. C.: Screw Worms and Other Maggots Affecting Animals. U. S. Dept. of Agriculture, Farmers' Bulletin No. 857.

[9] Buchman, J., and Blair, J. E.: Maggots and Their Use in the Treatment of Chronic Osteomyelitis. Surg., Gynec., and Obstet., vol. lv, p. 177, 1932.

[10] Child, F. S., and Roberts, E. F.: The Treatment of Chronic Osteomyelitis with Live Maggots. New York State Jour. of Med., vol. xxxi, p. 937, 1931.

[11] Cohn, I.: Some Observations on Osteomyelitis. Am. Jour. of Surg., vol. xv, p. 237, 1932.

[12] D'Herelle, F.: The Bacteriophage and Its Behavior. Baltimore, Wilkins and Williams, 1921.

[13] D'Herelle, F.: General Principles of Treatment with Bacteriophage. Read before the Annual Meeting of the Alumni of the Hospital for the Ruptured and Crippled, New York, November, 1932.

[14] Drinkard, R. U.: Osteomyelitis. West Virginia Med. Jour., vol. xxviii, No. 1, January, 1932.

[15] Galbraith, J. H.: Treatment of Chronic Osteomyelitis. Pennsylvania Med. Jour., February, 1931.

[16] Goldstein, H. I.: Maggots in the Treatment of Infected Wounds, Complicated Fractures, and Osteomyelitis. Annals of Surgery, vol. xciii, p. 953, 1931.

[17] *Ibid.:* Maggots. Jour. Am.-Med. Assn., vol. xciv, p. 290, 1931.

[18] *Ibid.:* Maggots in the Treatment of Wounds and Bone Infections. Jour. of Bone and Joint Surg., vol. xiii, p. 476, 1931.

[19] Hall, E. S.: The Use of Maggots in the Treatment of Wounds. Jour. of Maine Med. Assn., vol. xxiii, No. 3, April, 1932.

[20] Hegner, C. F.: Maggots in the Treatment of Chronic Osteomyelitis. Colorado Med. Jour., vol. xxviii, 1931.

[21] Hewitt, J. F.: Osteomyelitis, Development of the Use of Maggots. Am. Jour. of Nursing, vol. xxxii, No. 1, January, 1932.

[22] Johnson, A. B.: Operative Therapeusis. Vol. ii, p. 452, New York, D. Appleton & Co., 1921.

[23] Livingston, S. K.: Maggots in the Treatment of Chronic Osteomyelitis, Infected Wounds and Compound Fractures. Surg., Gynec., and Obstet., vol. liv, p. 702, 1932.

[24] Livingston, S. K., and Prince, L. H.: The Treatment of Chronic Osteomyelitis with Special Reference to the Use of the Maggot Active Principle. Jour. Am. Med. Assn., vol. xcviii, p. 1143, 1932.

[25] McNeal, W. J.: The Use of Bacteriophages in Wound Infections and in Bacteremias. Am. Jour. of Med. Sci., vol. lxxxiv, p. 805, 1932.

[26] Martin, W., and Heeks, G. H.: Maggots and Osteomyelitis. ANNALS OF SURGERY, vol. xcvi, p. 930, 1932.

[27] Miller, D. F., Doan, C. A., and Wilson, E. H.: The Treatment of Osteomyelitis (Infection of Bone) with Larvæ. Ohio Jour. of Science, vol. xxxii, No. 1.

[28] Murdoch, F. F., and Smart, T. L.: A Method of Producing Sterile Blowfly Larvæ for Surgical Use. U. S. Naval Med. Bull., vol. xxix, p. 406, 1931.

[29] Myers, J., and Czaja, L. M.: Maggot Treatment of Osteomyelitis. Ill. Med. Jour., vol. lx, p. 124, 1931.

[30] Orr, H. W.: The Treatment of Osteomyelitis and Other Infected Wounds by Drainage and Rest. Surg., Gynec., and Obstet., vol. xlv, p. 658, 1927.

[31] Pomeranz, M. M.: Peculiar Regeneration of Bone Following Maggot Treatment of Osteomyelitis. Radiology, vol. xix, p. 212, 1932.

[32] Robinson, W.: The Rearing of Blowflies and the Culture of Sterile Maggots for Use in Osteomyelitis. Circular E-296, Division of Insects Affecting Man and Animals, Bureau of Entomology, U. S. Depart. of Agriculture, March, 1932.

[33] *Ibid.:* The Use of Blowfly Maggots in the Treatment of Osteomyelitis and Certain Other Diseases. Circular E-295, Division of Insects Affecting Man and Animals, Bureau of Entomology, U. S. Depart. of Agriculture, March, 1932.

[34] Van Dessel, A.: Behavior of Sequestræ in Chronic Osteomyelitis. Jour. of Bone and Joint Surg., vol. viii, p. 194, 1926.

[35] Weil, G. C., Henry, J. P., Nettrour, S., and Sweadner, R.: The Cultivation and Sterilization of the Fly Larvæ or Maggot. West Va. Med. Jour., vol. xxvii, p. 458, 1931.

[36] Weil, G. C.: Nettrour, S., and Rohm, R.: Treatment of Acute Hematogenous Osteomyelitis. Penn. Med. Jour., vol. xxxiv, p. 313, 1931.

[37] White, G. F.: Production of Sterile Maggots for Surgical Use. Abst. in Jour. Parasitology, vol. xix, p. 170, 1932-1933.

[38] Wilson, E. H., Doan, C. A., and Miller, D. F.: The Baer Maggot Treatment of Osteomyelitis. Jour. Am. Med. Assn., vol xcviii, p. 1149, 1932.

THE PROBLEM OF RECURRENT HERNIA*

By Calvin M. Smyth, Jr., M.D.
of Philadelphia, Pa.

In this paper the term hernia is applied to the inguinal variety. Hernia or "rupture" is one of the oldest recorded ills to which the human body is heir and with few exceptions all of the "fathers of medicine" have somewhere mentioned it. The earliest recorded attempts at operative correction are credited to Celsus. Ambroise Paré practised removal of the sac, as did other surgeons of his period and even today a few adhere to the dictum that high removal of the sac is the only factor of importance in the successful radical cure. The modern conception of the surgery of hernia dates from the work of Bassini in Italy and Halsted in this country. Following the introduction of the Bassini operation in 1889, it was unreservedly announced, and apparently accepted, that the problem of hernia had been solved. While the value of Bassini's contribution must not be underestimated, it is nevertheless true that there was about as much truth in the foregoing statement as in Paré's assurance in the sixteenth century that surgery was finished. The complacence with which surgeons everywhere had come to regard their results in hernia operations was rudely shaken with the advent of that great iconoclast, the Follow-up Clinic. It soon became apparent that every surgeon who operated upon hernias failed to cure some of his patients and by this is not meant those patients in whom the result was obviously unsatisfactory at the time of discharge from the hospital. The percentage of recurrences stimulated a number of surgeons to carefully examine and inquire into the reasons for this state of affairs, although it was with no little amazement that the writer learned when requesting information regarding the recurrence rate in one of the largest surgical clinics in this country, that no figures were available.

Lahey, over a ten-year period (1919–1929), reported that out of 394 patients operated for inguinal hernia, 150 patients returned for follow-up examinations; thirteen, or 8.7 per cent., of these patients had recurrences. Further analysis of this group of patients shows that the rate of recurrence in bilateral hernioplasty is higher (18.1 per cent.). Direct hernias had a recurrence rate of 7.8 per cent., while the indirect had 4.6 per cent. Regarding the type of operation employed, Lahey states that the greatest number of recurrences (11.7 per cent.) occurred following repair with autogenous fascial sutures.

T. Turner Thomas states that the recurrence rate in operations for inguinal hernia is 7.46 per cent. for all types; in direct hernia, 16.61 per cent. recurred; while for the indirect group the rate was 3.15 per cent.

* Read before the Philadelphia Academy of Surgery, March 6, 1933.

In a paper unfortunately never published, the late George G. Ross reported in 1921, 132 consecutive inguinal hernoplasties without a recurrence. These cases were all examined by Doctor Ross and the writer. This is of considerable interest in view of the fact that Ross invariably did the Ferguson operation, which is now considered inferior to many other procedures. It suggests that the type of operation is of secondary importance when compared to the skill with which it is carried out.

Impressions, while in a measure unreliable, are of some value, and when one surgeon of large experience states that in something over 700 hernioplasties in children, he can recall but three recurrences, due consideration must be given. Certain it is that the problem is vastly different in children than in adults and that conclusions drawn from an experience largely confined to these young patients do not apply to the problem in general.

With this introduction it is now proper to consider specifically and in some detail the factors which contribute to recurrence following radical operation:

(1) *Selection of Patients for Operation.*—In patients whose tissues are obviously bad material with which to work, either as the result of constitutional disease, excess fat, advanced age, *etc.*, the healing powers are greatly reduced and an unsatisfactory result must be expected. In patients otherwise fit, focal infections, chronic upper respiratory disease with habitual cough or prolonged coagulation time, the chances of failure are definitely increased and operation is best deferred until the condition is remedied.

(2) *Choice of Anæsthetic.*—While hernioplasty is usually an elective procedure and not one calculated to produce shock or other disturbing complications, inhalation anæsthesia doubtless contributes factors making for failure, such as post-operative retching and vomiting, the exaggeration of a quiescent bronchial condition with the production of cough and the consequent strain placed upon the site of operation. Local or spinal anæsthesia would appear to be advisable in cases where the slightest doubt exists.

(3) *Nature and Extent of the Operation.*—Regardless of the specific technic employed, all hernia operations have two points in common: namely, ligation and removal of the sac and obliteration or reconstruction of the canal. The first of these may be dismissed briefly. The only difference of opinion lies in the value of the various methods of transplanting, transposing or anchoring the stump of the sac, in contrast to simply dropping the stump and allowing it to retract beneath the muscles. Concerning the treatment of the canal, much more must be said. This may best be appreciated by an analysis of the various steps involved in the Bassini operation, especially since this operation or some modification of it is more universally practised than any other form of hernioplasty. The essentials of the Bassini operation are: (*a*) The high ligation and removal of the sac; (*b*) the obliteration of the inguinal canal by suturing the internal oblique (or the conjoined internal oblique and transversalis) muscle to the shelving margin of Poupart's

ligament beneath the spermatic cord; (*c*) the suture of the aponeurosis of the external oblique above the cord and the closure of the skin. It is readily seen that this operation totally disregards certain anatomical factors of importance.

The component parts of the body are held together by fibrous connective tissue in the form of ligaments and fasciæ. In the retention of the abdominal contents the most important structures are the transversalis or endo-abdominal fascia and the aponeurosis of the external oblique. The muscles are of secondary importance. In indirect inguinal hernia, the openings in these fasciæ are the two chief points where, if incompetence exists, the major invitation to hernia occurs. It therefore follows that the transversalis fascia and the aponeurosis of the external oblique are the structures entitled to the major consideration in any operation for the cure of hernia. The Bassini operation completely ignores the transversalis fascia at the internal ring or elsewhere, and the aponeurosis of the external oblique is incised to permit access to the hernial sac and in the reconstruction it is merely sutured together, restoring the same condition which existed prior to the operation. Another fundamental defect in the Bassini operation is the assumption that red muscle will permanently fuse with white fascia when the two are approximated by suture. That this is a fallacy has been demonstrated by Koontz, Edmund Andrews and others. The fact that the number of recurrences after hernia operations is not greater may, in the light of our present knowledge, be used to support the contention of Russel that high removal of the sac is the only important step in hernioplasty, and this is probably true in the simpler hernias in adults and in practically all hernias in children. It is the complicated hernia, however, that engages our attention and which is the one prone to recur.

The Stettin operation was conceived with the idea of eliminating some of these inadequacies of the Bassini operation and while constituting a definite advance, nevertheless failed to consider all of the points mentioned. For a time the writer employed the Stettin technic in almost every case, but was led by three failures to assume a more critical attitude. The disadvantages of this operation are that the transversalis fascia and the internal ring are disregarded; that red muscle is sutured to white fascia; that the obliquity of the canal is destroyed by placing the new external ring opposite the internal ring, and, finally, that the transverse incision required in order to suture the aponeurosis of the external oblique about the cord leaves a definite weak point in the fascia and constitutes an invitation to recurrence. It was at this point that the three recurrences mentioned occurred.

Failure to consider the facts enumerated above must inevitably be responsible for many unsatisfactory results.

Suture material becomes a matter of minor importance when we remember that the ultimate union is of the tissues themselves, the function of any suture being to temporarily hold in apposition the structures until the normal healing process has been completed, and having served that purpose, has

done all that it can do. Sutures placed into tissues under tension defeat their own purpose by pressure necrosis and the subsequent separation of the structures they attempt to hold together. Therefore, it would seem to make little difference in the ordinary case whether one uses plain or chromicized catgut, kangaroo tendon, autogenous or preserved fascia, or silk.

In those cases where there has been such disturbance of the normal relations as to produce actual defects, we are faced with a different problem. Here no approximating suture as such can accomplish anything, for, as we have stated, the tension under which such sutures must be placed defeats the objective. It is in the repair of such defects that the fascial suture is of great value, although the term suture is a misnomer, as what is really done is to weave or darn the fascia into the structures bounding the defect and not to draw those structures together. The original use of fascia by McArthur is quite different from that described at a later date by Gallie and LeMesurier. McArthur used a strip of fascia taken from the aponeurosis of the external oblique left attached at one end, the free end being threaded upon a needle and used to suture the conjoined muscle to Poupart's ligament. Gallie and LeMesurier used strips of autogenous fascia lata for the bridging of defects and demonstrated the difference from and the superiority to free fascial grafts for this purpose. The use of ox fascia preserved in alcohol advocated by Koontz has the advantages of unlimited supply and the elimination of another operation for obtaining the sutures. Although some of the difficulties first encountered with ox fascia have been overcome, it would appear that the liability to infection and necrosis is greater than when autogenous fascia is used. Experimental evidence also indicates that autogenous fascia becomes permanently incorporated in the tissues while the ox fascia is eventually absorbed. There would appear to be little indication for the routine use of any fascial suture in the performance of hernioplasty for indirect inguinal hernia or in direct hernia unless there exists a defect which cannot be repaired by simple suture without tension.

It is not the writer's purpose to advocate a particular operation for every case but to suggest that a rational hernioplasty should include the following:

(1) Closure of the internal ring.

(2) Preservation of the obliquity of the inguinal canal.

(3) The suture of fascial structures to each other and not of fascia to muscle.

The operation which we have come to employ routinely in inguinal hernia, whether direct or indirect, is carried out along the lines suggested by Edmund Andrews, "white fascia operation," with certain modifications. The canal is opened and the sac treated in the usual manner. The transversalis fascia is then sutured to the shelving margin of Poupart's ligament from the internal ring to the spine of the pubis, using interrupted sutures of No. 1 chromic catgut placed about one centimetre apart. The conjoined muscle is disregarded. The mesial leaf of the external oblique aponeurosis is then sutured to the shelving margin beneath the cord. Andrews, at this point, roofs over

the cord with the lateral or lower flap of aponeurosis. This seems to us an unnecessary step and wastes valuable fascia that might be put to better use. Our practice is to suture this leaf or flap to the mesial flap beneath the cord, thus giving one more fascial reinforcement to the canal. Two or three interrupted sutures bring the mesial flap over the cord in the upper angle, to preserve the obliquity of the canal. Placing of the cord immediately beneath the skin has caused no unpleasant symptoms in our experience. Sutures of fascia lata are used in all cases where the patient's own fasciæ are inadequate and routinely to close the larger defects at the site of a direct hernia.

Post-operative Treatment.—The immediate post-operative management of hernioplasty need not differ from that of any abdominal section except that the patient should be kept flat for a somewhat longer period. As to the length of this period some difference of opinion exists but it varies in different clinics from twelve to twenty-one days. Rigid dressings are no longer employed by many. The removal of skin sutures should be made as in any other operation since the skin wound has no bearing upon the integrity of the operation. Wound infection is a distressing post-operative complication as it may destroy the result of a mechanically perfect procedure. Therefore, all precautions must be taken to guard against it. Hæmostasis must be rigid and provision made at operation for the escape of serosanguinous fluid before the wound is subjected to pressure. A few strands of silkworm gut placed in the wound for twenty-four hours do no harm and may be the means of preventing trouble. Other matters such as cautioning the patient against too early return to strenuous occupations and particularly against lifting heavy objects while the knees and hips are in flexion (squatting position) are, of course, to be considered.

From the foregoing observations certain conclusions may be properly drawn:

(1) The rate of recurrence following inguinal hernioplasty is higher than was thought prior to the institution of follow-up clinics.

(2) The Bassini operation as usually performed is an inadequate procedure, principally because of the failure to consider certain, now established, anatomical and physiological facts.

(3) Not one factor, but several, must be borne in mind in improving the results of operations for radical cure of hernia.

GUNSHOT WOUNDS OF THE ABDOMEN

A REVIEW OF TWENTY-TWO CASES

By Duval Prey, M.D., and Jno. M. Foster, Jr., M.D.

of Denver, Colo.

From the Surgical Service of the Denver General Hospital

Twenty-two patients suffering from gunshot wounds of the abdomen, who later received the benefit of surgical intervention, were admitted to the Denver General Hospital during the period, 1928 to 1933. The mortality rate in this series was 68 per cent., which corresponds with similar statistics as reported in the literature from other general hospitals throughout the United States. Loria[8] reports 122 cases observed at the New Orleans Charity Hospital, with eighty deaths; Mason,[10] of Birmingham, records thirty-three deaths in fifty-eight cases; while Condict,[2] of New York City, had nine deaths in twenty cases. These statistics when compared with those reported by Crawford,[4] in 1910, indicate that the mortality rate for similar injuries has not been appreciably improved in the last two decades. The extremely slow progress that has been made in the treatment of these injuries is further emphasized by an historical review.

In civil life, bullet wounds of the abdomen first became prevalent through the custom of pistol dueling. At that time surgery was indicated only when the abdominal contents had eviscerated. Later, during the War of the Rebellion, the mortality rate for penetrating wounds of the abdomen was found to be approximately 90 per cent., because surgical intervention was instituted only when the hæmorrhage was too profuse to be controlled by bandages. In such circumstances, the procedure consisted simply in enlarging the abdominal wound and ligating the bleeding vessel. It was not until the Spanish-American War that an effort was made to completely repair the intra-abdominal damage, and then only five cases were given the benefit of operative interference. During this period the mortality rate was variously estimated at 80 to 90 per cent. However, by 1910, surgical repair was generally accepted as the proper mode of treatment, and, as a result, the mortality was immediately reduced to approximately 60 per cent., a figure at which it now stands.

The three predominant factors determining the gravity of gunshot wounds of the abdomen are: (1) the degree of visceral damage; (2) the amount of hæmorrhage; and (3) the time elapsed fom the injury to the completion of its surgical repair. With this idea in mind, a chart is presented of all cases of gunshot wounds of the abdomen receiving the benefits of an operative procedure, which were admitted to the Denver General Hospital during the past five years.

The first factor, namely, the mischief caused by the bullet's course through

the abdominal cavity, must of necessity remain outside the realm of surgical control, and for this reason certain injuries will always command a high mortality rate. For instance, a wound of the hollow viscera is more dangerous than is a like injury to a solid organ, and a tear in the liver or spleen is not as hazardous as is one of the pancreas, while a perforation of the stomach and small intestine is less serious than a similar injury to the large bowel. Further, the more numerous the perforations, the more difficult is their isolation and suture, and the greater is the resulting risk.

CHART I

Gunshot Wounds of the Abdomen

Case Number	Time from Injury to Operation in Minutes	Operating Time in Minutes	Total Time in Minutes	Pathology	Hemorrhage	Recovered	Died	Transfusion	Time from Injury to Transfusion in Hours
34059	115	55	170	Perforations of Colon	----	X		0	0
34710	190	97	287	Perforations of Colon	--		X	0	0
36639	120	58	178	Perforation of Stomach & Pancreas	--	X		0	0
38095	150	60	210	Perforation of Colon	?		X	0	0
38664	90	48	138	Perforations of Jejunum	?	X		0	0
40039	110	50	160	Perforation of Ileum & Colon	---		X	0	0
44787	207	64	271	Section of Ureter	----		X	0	0
46081	115	45	160	Perforations of Ileum	?		X	0	0
46700	420	40-	460-	Perforations of Ileum	----		X	0	0
60496	102	58	160	Perforations of Ileum	?	X		0	0
61454	68	63	131	Perforation of Stomach	----		X	0	0
61703	94	56	150	Perforation of Liver & Stomach	--	X		0	0
62461	260	50	310	Perforation of Liver	?		X	X	16
64697	258	125	383	Perforations of Ileum	---		X	X	6
72912	510	30	540	Perforation of Liver & Kidney	--		X	X	20
73304	187	57	244	Perforation of Liver & Stomach	---	X		X	10
76082	80	70	150	Perforations of Ileum	?		X	X	24
76975	195	65	260	Perforations of Ileum	--		X	0	0
79868	164	143	307	Perforations of Ileum	-----		X	0	0
81132	85	50	135	Perforation of Stomach	---	X		X	5
85171	140	65	205	Perforations of Ileum	?		X	0	0
85173	195	95	290	Perforation of Colon	--		X	0	0
				Summary					
Average	113	55	168			32%			7 1/2
Average	191	70	279				68%		18 1/2

The second factor, that of hæmorrhage, is partially under surgical control, and according to many authorities[1, 3, 5, 6, 7, 9, 11] is frequently disregarded because of a general inappreciation of its significance. Mason, of Birmingham, suggested, after a study of many case records, that the shock present in these injuries was the direct result of the hæmorrhage. If this statement is accepted, then it furnishes additional evidence in favor of the value of early surgical intervention. Six of the cases reported in this paper received one or more transfusions, but due to delay they were often given too late to be of any real value. The average time in this series, from the injury to the transfusion, was fourteen hours.

The third, or time factor, is definitely under our control, but is often neglected. We know that the mortality rate in a ruptured peptic ulcer increases in inverse ratio to the time elapsed after the accident. We also know that the course of a bullet is frequently most fanciful, and because many of these patients are in a most excellent condition upon our first examina-

tion, we delay surgical intervention until such symptoms have arisen, which by their very presence, indicate the patient's condition to be hazardous. Cases Nos. 61703 and 61454 furnish excellent examples of the splendid condition in which a patient may appear with a gunshot wound of the abdomen.

Case No. 61703 is that of a seamstress, aged fifty-two, who was shot by her husband during a drunken quarrel. The bullet entered the left upper quadrant of the abdomen and lodged in the musculature of the back near the ninth dorsal vertebra. Upon entrance to the hospital, approximately thirty minutes after her injury, she was in practically no shock, with a pulse rate of 78 and a temperature of 99.4° F. The abdomen showed a small puncture wound just below the left costal margin in the mid-clavicular line. There was no distention present, and only a slight splinting of the muscles near the wound, with moderate dullness in the left lumbar gutter. The patient had not vomited and was having no pain. An immediate operation was performed, and the bullet was found to have transversed the left lobe of the liver, and penetrated both walls of the stomach.

The second case, No. 61454, demonstrating this same phase, is that of a man, aged twenty-eight, who had been on a drinking bout at a friend's home, and because he expectorated upon the rugs, he was shot through the abdomen at close range. When he entered the hospital, which was forty-five minutes following the accident, he was not in appreciable shock, was very talkative, and on examination showed a penetrating wound in the epigastrium, and dullness in both lumbar gutters. At the subsequent operation, which was performed immediately, the bullet had passed through both stomach walls, with its point of exit to the right of the vertebral column.

The time elapsed before the operation is performed is of vital importance, as is clearly shown in this series. (See chart.) The average time for this period in those cases that lived, was one hour and fifty-three minutes, while for the cases that died, there was more than one full hour longer of delay, or an average pre-operative time of three hours and eleven minutes. This factor is generally understood, but the danger of even the slightest delay is not fully appreciated. These patients represent real surgical emergencies, and must be respected as such if we desire to improve the excessive present-day mortality rate. Further, the same procrastination must be absent from our surgical procedure. The quickest, easiest, most logical, and surest method of repair will give the most satisfactory result.

This fact is demonstrated most forcibly by an analysis of the operating time in each case. The average operating time for the cases terminating fatally was one hour and ten minutes; four cases only, consuming less than one hour, and in four instances the procedure required over one hour and thirty minutes. The average time consumed by the surgery in the cases that survived was fifty-five minutes, and none required over one hour. For the two individuals that lived one week and two weeks, the surgical procedure occupied fifty minutes and one hour and ten minutes respectively. It is also interesting to note that every case necessitating resection of the intestine died. It is frequently suggested that in dealing with perforations in the small intestine, it is easier, simpler and therefore quicker to resect that segment of gut, than it is to suture the wounds separately. This is occasionally true, but only rarely, particularly if a lock stitch is used for the repair

of the larger perforations. This suture has the advantage of giving a most satisfactory closure and requiring a minimum amount of time for its execution. Of course, the time consumed for the surgical repair depends largely upon the extent of the intra-abdominal damage, but with a more general appreciation of the necessity for expeditious surgery, every possible means of surgical knowledge will then be utilized to serve this purpose.

It is certainly most pertinent that in this entire series not one of the patients who recovered had a surgical procedure requiring more than one hour's time to complete. Too much emphasis cannot be placed upon the single factor that a supreme effort must be made to complete the surgical repair within this time.

To this end this paper is dedicated; that we may have a more definite and systematic mode of care, which will alleviate delay and thereby bring to a more happy conclusion many of the cases of gunshot wounds of the abdomen. To delay is to destroy, and unless we are absolutely familiar with the most rapid method of attack and repair, many of our cases must necessarily be doomed to failure.

With this idea in mind, the following tabulated suggestions are made as a means of obviating a few of the petty delays which are encountered in the treatment of these cases.

(1) In most cities, patients suffering injuries of this nature are cared for in the general hospitals, and usually are promptly transported to the emergency room. The interne then notifies the staff officer and awaits his arrival and subsequent examination before ordering the operating room to be prepared. When it is appreciated that even the loss of one-half to one hour is of paramount importance to their successful outcome, then only will the internes be encouraged to order the operating room immediately upon the arrival of the patient in the emergency ward.

(2) At the same time that the notification to the staff surgeon is given, the house interne should begin the necessary arrangements for a transfusion. This can seldom be accomplished under one hour's time, but if the preparations have been started early, the transfusion frequently can be given before the surgical procedure, and if not, immediately upon its completion. According to many authorities, those cases showing moderate to severe bleeding have a higher mortality rate than those with only slight hæmorrhage. The procedure of transfusion then becomes of prime importance to their proper surgical care.

(3) The degree of shock present, whether it is due to a loss of blood volume; the result of an increased permeability of the capillaries, dehydration, or hæmorrhage, must be treated immediately, and to this end an intravenous infusion should be started at once; the patient should be placed on shock blocks, and external heat applied. This phase of the surgical treatment is seldom neglected, and the desire of this paper is only to emphasize the value to be obtained by its immediate application.

(4) The size of the incision must be sufficiently ample to permit easy

visualization and exploration of the abdominal viscera. Fortunately, it no longer is an indication of good surgical technic to work through small, button-hole like incisions, but even so, the tremendous advantages of a liberal wound are not fully appreciated. Nothing so facilitates an easy and rapid surgical procedure; and as a careful exploration is an absolute necessity in this type of injury, the incision must be generous enough to easily permit its performance. Further, it is an accepted fact that a large wound shows no greater tendency to hernia formation than does a small one, and as our desire is to repair the damage in the least possible length of time, then we must necessarily have an ample incision in order to accomplish this objective.

(5) Because hæmorrhage is always present, and an accumulation of blood will uniformly be encountered upon opening the abdomen, a satisfactory apparatus for suction should be at hand for immediate application upon entering the peritoneal cavity.

(6) In the event the bullet has penetrated the liver, the operative procedure is simply to control the subsequent hæmorrhage resulting from the laceration of this organ. Although there are numerous means suggested for suturing the liver, all are time-consuming, and it has been shown most clearly that tamponade alone will prove sufficient. As our desire is to accomplish the control of the hæmorrhage in the shortest possible time, then packing should be utilized for this purpose in every case where a solid organ has been injured. It has been suggested that a packed liver is prone to subsequently develop an abscess. This danger undoubtedly has been greatly exaggerated, because not only in this series but in the last fifteen years, at the Denver General Hospital, autopsy records fail to reveal the presence of a single liver abscess resulting from tamponade.

(7) Should the bullet have pierced both stomach walls traveling from before backward, it will regularly be noticed that the wound in the anterior wall is small, while that in the posterior is much larger. By enlarging the opening in the anterior wall by means of a linear incision in the direction of the long axis of the stomach, the posterior wound may be sutured through this incision with comparative ease. The readiness with which this may be consummated in comparison to suturing the tear in the posterior wall of the stomach by an approach through the mesocolon is most astounding.

(8) Large tears of the stomach or bowel frequently present difficulty in closure. In our experience we have repaired these wounds by means of a lock stitch in preference to the Lembert suture, because of its comparative ease and rapidity of execution, and not once have we regretted its employment. This is accomplished by placing two Allis forceps at each angle of the wound, one near the mesenteric border of the intestine, and the other directly opposite, then by means of a continuous lock stitch, the wound can be sutured both rapidly and snugly. In repairing the stomach, the direction of the suture line should be in its long axis, except when it might interfere with the lumen at the pylorus.

(9) Frequently when the intra-abdominal damage has been most severe, and its repair necessarily time-consuming, we can facilitate the incisional closure by utilizing the method of approximating all layers with heavy through-and-through silk sutures. This method of closure has been used frequently enough in our own experience, as well as that of others, to justify its practice in every case when a rapid closure is essential.

The above suggestions have been offered as a means by which we may obviate some of the more common delays encountered in the treatment of gunshot wounds of the abdomen. There is no implication intended that they represent the only impediments to a brisk and speedy recovery, but it is hoped that by pointing to the more obvious hindrances to an expeditious surgical care, further study will be stimulated; to the end that the employment of immediate, rapid surgery will subsequently reduce the embarrassing present-day mortality rate.

BIBLIOGRAPHY

[1] Bull, H. R.: Gunshot Wounds of the Abdomen.–Colo.–Medicine, vol. vii, p. 330, 1910.

[2] Condict, W. L.: Perforated Gunshot and Stab Wounds of the Abdomen Treated at the Gouverneur Hospital of New York. ANNALS OF SURGERY, vol. lxxx, p. 51, 1924.

[3] Conners, J. F.: Gunshot Wounds of the Abdomen. Surg. Clin. N. Amer., vol. iii, p. 563, 1923.

[4] Crawford, L. B.: Gunshot Wounds of the Abdomen. Statistics from the Charity Hospital, 1906-1913, and report of two cases operated on, New Orleans Med. and Surg. Jour., vol. lxvii, p. 1, 1914.

[5] Davis, M. B.: Gunshot and Stab Wounds of the Abdomen; 28 Cases and Immediate End-results. Jour. Tenn. Med. Assn., vol. xviii, p. 190, 1925.

[6] Guthrie, G. J.: Commentaries on the Surgery of the War, 1808-1815. Sixth edition, J. B. Lippincott Co., 1862.

[7] Horsley, J. S.: Surgery of the Stomach and Small Intestine. D. Appleton and Co., 1926.

[8] Loria, F. L.: Influence of Hemorrhage in Gunshot Injuries. ANNALS OF SURGERY, vol. xcvi, p. 169, 1932.

[9] Loria, F. L.: Visceral Injuries in Gunshot Wounds of the Abdomen. New Orleans Med. and Surg. Jour., November, 1927.

[10] Mason, J. M.: The Influence of Hemorrhage on the Mortality in Gunshot Wounds and Other Injuries of the Abdomen, with an Analysis of 69 Cases. ANNALS OF SURGERY, vol. lxxviii, p. 364, 1923.

[11] McGuire: Gunshot Wounds of the Abdomen, 150 Consecutive Operations for Penetrating Abdominal Wounds. Southwest Jour. Med. and Surg. vol. xxviii, p. 69, 1920.

EXPERIMENTAL STUDIES IN NERVE TRANSPLANTS*

By Loyal Davis, M.D., and David A. Cleveland, M.D.

of Chicago, Ill.

from the department of surgery of the northwestern university medical school

During the development of the surgical treatment of peripheral nerve injuries many methods of surgical repair have been described. These methods are all alternative to the method of choice, which is, of course, direct end-to-end suture of the nerve ends. Unfortunately, all of the suggested procedures are not based upon established physiological, histological or anatomical principles. The mass of experimental and clinical evidence which has accumulated concerning these methods, particularly during and since the Great War, has been analyzed and evaluated rather accurately. Such analyses only emphsize the wide gap which exists between the functional results obtained by end-to-end nerve suture and those which follow the most successful of the alternative methods of repair.

There are many times when the ends of the divided nerves cannot be approximated easily and several procedures have been advocated in order to obtain an end-to-end union. Flexion or extension of neighboring joints, gradual liberation of the nerve trunk from its normal bed, gradual stretching, transposition of the nerve from its normal bed to a shorter anatomical course, or a combination of these procedures may bridge gaps as large as seven to eight centimetres.

There are instances, however, in which all efforts to effect an end-to-end suture fail. Several surgical procedures have been suggested for the repair of these large defects in nerve trunks. These operations may be classed as (1) nerve implants, (2) nerve flaps, (3) suture à distance, (4) tubulization, (5) nerve crossing and (6) nerve transplants or grafts.

Nerve implantation signifies the placing of the proximal end of the distal segment of a divided nerve into the substance of a sound nerve through a slit-like opening in the endoneurium. This method was devised by Létiévant,[1] in 1873, and has been frequently used in Germany particularly since Hoffmann[2] advocated it so strongly in 1884. Critical analyses by Stookey[3] and Pollock and Davis[4] show that the good results obtained are due to nerve crossing and not implantation. If the funiculi of the sound nerve are spread and the implanted nerve placed between them there are no anatomical nor physiological reasons why an uninterrupted neuraxon should enter the implanted stump. On the other hand, if the axis cylinders of the sound nerve are cut in the process of implantation these may very likely grow into the implanted nerve.

The nerve-flap operation also described originally by Létiévant, in 1872,

*Read before the Western Surgical Association, December 9, 1933.

involves the turning of a flap of part of the nerve from the central or distal end to bridge the defect. Regardless of the source of the flap no neuraxons connected with their cells of origin can be in apposition with the distal segment. This operation received considerable attention because of the reports of successful cases by Tillmanns[5] and Mackenzie,[6] but from his review of their cases Stookey[7] has presented positive evidence that regeneration had not occurred. The experimental work of Huber,[8] in 1895, is further proof of the futility of this operation.

In 1886, Assaky[9] proposed the operation of suture à distance as a method of supplying a scaffolding of sutures between the cut nerve ends along which neuraxons might grow to reach the distal segment. Although Huber obtained some evidence of regeneration in two instances, the majority of clinical and experimental evidence does not support this method. The danger of a barrier of dense connective tissue and the uncertainty of the scaffolding should be sufficient to question the logic of this procedure.

Tubulization has been suggested many times since Gluck[10] used the central canal of a decalcified bone drain to form an uninterupted pathway between the separated ends of a divided nerve. Various types of tubular structures, including rubber tubes, rolled gauze, fat and fascia sheaths, hardened and fresh blood-vessels, and hardened gelatin, have been used; but most of the clinical and experimental evidence lends little support to this method.

Nerve crossing, often called anastomosis, dates back to 1828 when Flourens[11] successfully crossed the median and radial nerves. The experimental and clinical results speak for histological and functional regeneration when nerves of like function are united. Philipeaux and Vulpian[12] succeeded in joining the lingual and hypoglossal nerves and concluded that functional regeneration will occur between sensory and motor nerves. Histological studies made by Langley and Anderson[13] demonstrated that fibres will grow from the anterior crural nerve into the external saphenous. Similarly, Boeke[14] was able to follow fibres from the hypoglossal through the lingual to the epithelial layers of the tongue. Although these experiments show that histological regeneration of neuraxons may take place between sensory and motor nerves, there is little evidence to demonstrate the return of functional activity. It may be stated that crossing of nerves of similar function has a distinct place in the surgical treatment of nerve lesions. There are a large number of cases reported in the literature in which successful results have been obtained. Reference need be made only to the excellent functional results obtained by innervation of the facial muscles when the hypoglossal or other cranial nerves are joined to the distal end of the facial nerve following facial paralysis.

Nerve transplantation, or grafting, in humans dates from 1878 when Albert used a nerve from an amputated limb to bridge a three-centimetre gap following the removal of a sarcoma from the median nerve. Primary union took place but no further report of the clinical course is available. In a second case the transplanted ten centimetres of the posterior tibial

nerve to fill in a defect in the ulnar after a neurofibroma of that nerve had been resected. There was a complete slough of that transplant. In 1880, Kaufmann bridged a gap in the radial nerve with a graft from the sciatic nerve of a dog. The first entirely successful nerve graft reported is that of Mayo-Robson,[15] who, in 1888, transplanted 2.5 centimetres of the posterior tibial from an amputated limb between the separated ends of the median nerve. In 1906, Sherren[16] collected reports of eight cases from the literature of auto- and homogeneous transplants in only three of which had sufficient time elapsed after operation to admit of recovery. Of these, two recovered completely. He also reviewed the reports of twenty-two cases in which heterogeneous grafts had been used. In sixteen of these a sufficient period after operation had elapsed for recovery to have taken place, but only six of them showed improvement and one, definite recovery of function.

From the experimental standpoint Huber,[8] Nageotte,[17] Jiuanu,[18] Cajal[19] and others have shown that nerve grafts are feasible. The classical experiments of Huber and his co-workers,[20] performed under the auspices of the government during the Great War, demonstrated very clearly, at least from the histological point of view, that nerve grafts may result successfully. From the twenty-one series of experiments totaling 279 operations, Huber concluded, "The results of all the experimental work on nerve transplantation indicate clearly, it seems to me, that the most favorable results are to be obtained after the use of auto-nerve transplant and for practical surgery a cable-auto-nerve transplant, using several segments of a cutaneous sensory nerve to bridge a defect in a larger motor-sensory nerve. The question of the type of nerve is not material; the question of the funicular arrangement is of secondary importance; whether the central or distal end of the transplant is placed centrally is not necessary of consideration; accurate and end-to-end suture, careful technic, and dry field, are essential, I believe. As concerns fresh homo-nerve-transplants, I believe I am justified in stating that they serve the purpose of bridging nerve defects quite as well as auto-nerve-transplants, if available, which would very probably not often be the case in practical surgery."

Following the suggestion of Dujarier and Francois[21] of using nerves stored in sterile vaseline at 2° C. and Nageotte's use of 50 per cent. alcohol as a storage medium, Huber was able to demonstrate regeneration after both methods. Huber[22] also found that non-degenerated heterogeneous nerves were more satisfactory than those that had undergone degeneration, but under no circumstances were they as satisfactory as autogenous or homogeneous nerve transplants. Verga[23] found that a homogeneous or heterogeneous graft from a cadaver always united but later degenerated. According to Ingebrigtsen[24] the failure of heterogeneous transplants is due to necrosis of the transplanted portion and the only hope of success lies in the use of autogenous and homogeneous transplants. On the other hand, Jiuanu[18] believes that dead grafts are superior to fresh ones and in his experimental studies used 2 per cent. formalin as a storage medium.

Although the majority of reports which deal with the results of nerve grafts in experimental work lend support to this type of operation to repair large nerve defects, the attitude of the majority of surgeons in this country and in England is one of doubt as to the ultimate value of nerve transplants. On the other hand, French surgeons are more optimistic and believe that functional results can often be obtained. Depage[25] recommended the use of autogenous nerve grafts when end-to-end suture is not possible and Gosset[26] and Joyce[27] also reported successful results from nerve transplantation. On the contrary, Stopford[28] and Platt[29] have supplied a detailed report of the failure of functional recovery in thirty instances. Platt and Bristow[30] stated that an unbiased study of the results of the various bridging operations showed that there was no justification for their continued inclusion in the repertoire of peripheral nerve surgery, that nerve grafting should be done only as a last resort and that there are only a few instances in which it is justified. Lewis considered that autogenous transplants were superior to homogeneous and heterogeneous grafts but unlike Lexer[31] and Foerster[32] stated that he had never seen any functional results following the use of cable transplants. Stookey[33] and Lewis[34] both express the opinion that the development of a dense barrier of scar tissue at the distal suture line of the transplant may act as a barrier to the downgrowing neuraxons. Delangénière[35] stated that the success of nerve transplants diminishes with the increase in the length of the graft. Tinel[36] noted the appearance of tingling in distal portions of the extremity following the use of heterogeneous grafts and considered this as evidence of beginning regeneration, but after five or six months even this doubtful sign of regeneration had disappeared. Contrary to the general belief, Bunnell[37] has stated that he found evidence of regeneration following autogenous nerve transplants which had occurred almost as rapidly as that following a simple end-to-end suture. This seems rather strange if Cajal's calculations are accepted, that the rate of growth of neuraxons through scar tissue is about one-tenth as fast as through the distal portion of a severed nerve since in nerve transplants neuraxons must pierce two suture lines. Recently, Ballance and Duel[38] placed autogenous transplants in the Fallopian canal in lesions of the facial nerve and report returns of functional activity which are so uniformly successful that in view of past experiences one must become skeptical of their standards of estimating recovery. Nerve regeneration must occur from the central segment and the neuraxons must go downward into the distal segment. There is no reason to suppose that this should occur more rapidly in the facial nerve than in any other nerve of the body, and from the evidence produced by a large number of workers it is obvious that if regeneration occurs it must be more doubtful in cases in which transplants are used than in direct end-to-end suture.

The regeneration of neuraxons has been estimated to be about one millimetre a day. Therefore, the time required for them to grow the entire length of a nerve transplant would depend directly upon its length. Even though

a nerve suture is performed with meticulous attention to detail the rapid growth of connective tissue may afford a barrier which the regenerating nerve fibres cannot penetrate. The additional time necessary for the axons to grow down the length of the transplant, after they have passed the proximal suture line successfully, gives connective tissue an opportunity to form a dense obstruction at the suture line. Thus an otherwise successful nerve transplant may end in failure because neuraxons are unable to penetrate the connective-tissue scar between the distal end of the transplant and the distal end of the divided nerve. A series of experiments were undertaken to determine whether or not resection of this scar-tissue barrier and resuture of the distal end of the transplant and the distal end of the nerve would allow the neuraxons to enter the distal segment of the divided nerve. An exhaustive survey of the literature failed to show that this type of experiment had been performed, although Stookey and Lewis have suggested that such an operation might be feasible.

EXPERIMENTS.—The sciatic nerve in a dog was exposed from its entrance into the thigh to the point of its division. A section of the nerve varying from three to seven centimetres in length was removed with a thin, sharp razor blade. This produced a defect in the nerve trunk analogous to those which are encountered in lesions of the peripheral nerves in man in which a loss of substance has occurred. The removed section was then replaced as an autogenous graft. In some experiments, this graft was reversed end for end and in others it was replaced in the same position from which it had been removed. In some, attention was paid to maintain the original topographical funicular anatomy while in others this was disregarded entirely. Fine waxed single strands of untwisted Corticelli triple A silk threaded on fine curved needles were passed through the epineural sheath of both the nerve and the graft. Care was taken to have each suture pass through the sheath about one-sixteenth of an inch back of its edge. An average of eight such sutures were used at the central and distal suture lines. After all of the sutures had been tied the epineural sheath edges were everted slightly to insure good funicular approximation and to obviate a space between the end of the nerve and that of the transplant. In every case the sutures were not introduced until all bleeding had been controlled and the clots washed away with sterile physiological salt solution. The wounds were closed carefully in layers to prevent the presence of cavities in which serum or blood might collect. All of the animals were observed regularly and those which developed severe trophic sores or infections, usually incited by the animals chewing on the insensitive part, were discarded from the study.

Four groups of four animals each were used. In Group I the animals were re-operated upon forty-five days after the introduction of a nerve transplant of the sciatic nerve. The distal suture line scar was resected and the distal end of the transplant and the distal end of the nerve were resutured. In Group II the time interval between the first and second operations was sixty days; in Group III, seventy days; and in Group IV, eighty days. In every instance the type of operation was the same and the time limit only was varied. The nerves from sixteen animals were stained by Ranson's pyridine silver method and comprise the material upon which this report is based. The nerves from sixteen other animals are to be stained by other methods as a separate study. The time limit in all of the experiments was too short to permit a study of the return of functional activity.

GROUP I.—Four animals were re-operated upon forty-five days after the nerve transplant. The nerve was carefully inspected for the formation of neuromas and gross signs of the growth of neuraxons in the transplant and the distal segment of the

peripheral nerve. In all there was a fusiform swelling at the proximal suture line and in two in which the grafts were only three centimetres in length there were larger and more bulbous swellings at the distal suture line. In one nerve in which the transplant was six centimetres long there was a very slight swelling at the distal suture line. In another in which the transplant was four centimetres long the neuroma at the distal suture line was approximately the same size and shape as that at the proximal line of suture. In each of the animals the neuroma at the distal line of suture was resected and the distal end of the transplant and the end of the distal segment of the nerve were re-united as in a primary nerve suture. Dogs 1, 3 and 4 were killed forty-five days after the second operation. Dog 2 began to chew its foot on the thirty-fourth day and

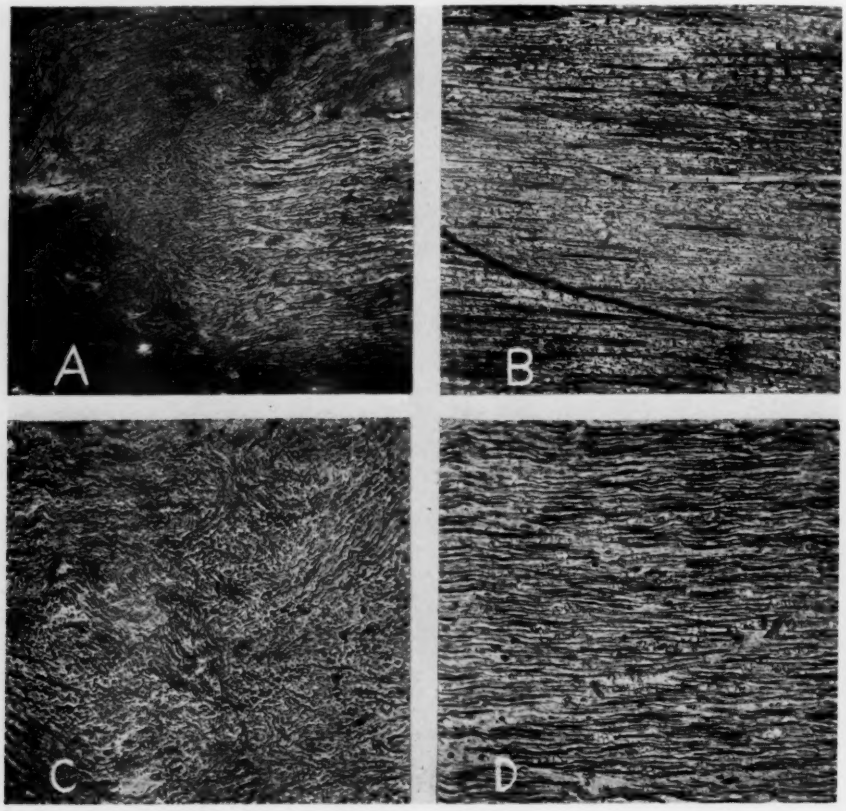


FIG. 1.—Microphotographs of (A), distal suture line forty-five days after primary suture; (B), distal nerve segment forty-five days after primary suture; (C), distal suture line forty-five days after resection and resuture of distal end of the transplant and the distal segment of the nerve; (D), distal nerve segment forty-five days after second suture.

was killed to prevent a severe infection. Microscopically, the histological appearances at the central line of suture were similar in all four specimens. That is, axons branched into fine unmyelinated neuraxes in the central end of the sound nerve where many of them ended as spirals or end-bulbs. Many others passed into a mass of connective tissue where they passed through a tortuous course before they again assumed a straighter path to enter the central portion of the transplant. Many of the neuraxes ended in the substance of the transplant but large numbers could be traced through in the serial sections to the end of the graft where branching again became more profuse as the neuraxons either ended or entered the scar tissue at the distal line of suture. The course of these neuraxons through this distal scar tissue was quite similar to that

seen in the proximal suture line except that more of them ended and fewer reached the distal segment of the peripheral nerve than was the case in the longer transplants. Sections of the neuromas resected at the secondary operation in all cases showed a rather heavy mass of connective tissue. The distal neuroma resected in the shorter transplant contained many intertwining neuraxes, none of which reached the distal segment of the nerve. The distal neuroma removed from the four-centimetre graft contained a very heavy connective tissue but very few neuraxes. The distal neuroma removed from the six-centimetre graft contained very dense connective tissue and no neuraxes. In all of the specimens that part of the distal segment of the peripheral nerve close to the line of suture showed a rather heavy sheath of connective tissue which constricted the

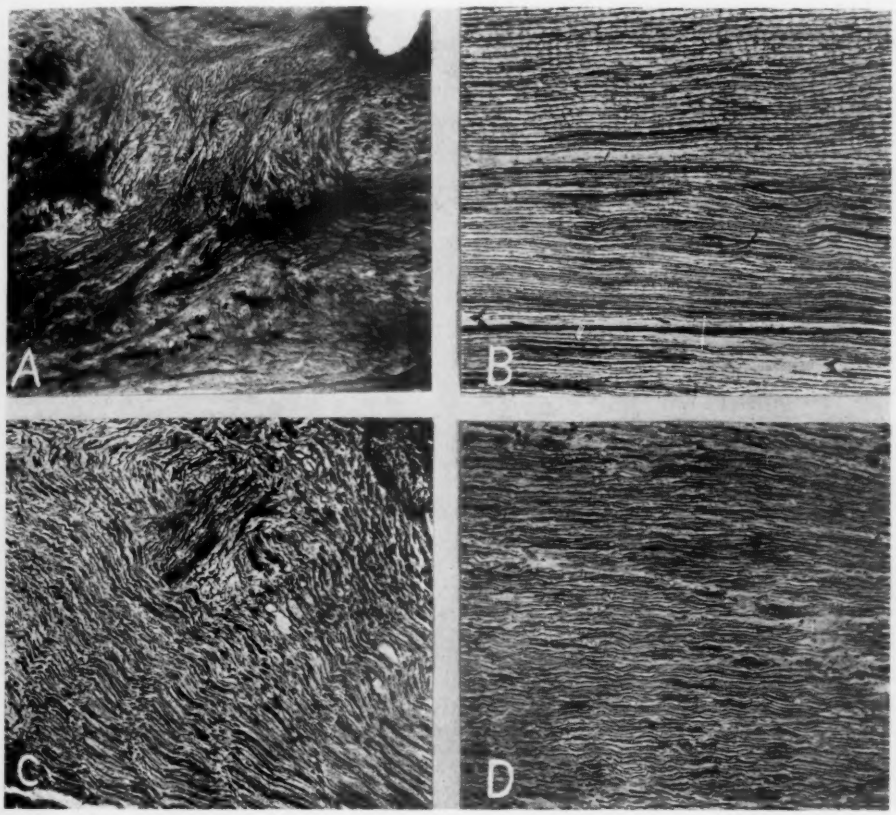


FIG. 2.—Microphotographs of (A), distal suture line sixty days after primary suture; (B), distal nerve segment sixty days after primary suture; (C), distal suture line sixty days after resection and resuture of distal end of the transplant and the distal segment of the nerve; (D), distal nerve segment sixty days after second suture.

potential lumen of the nerve. The thickness of this sheath tapered off to its normal size within a distance of one centimetre from the neuroma. (Fig. 1.)

GROUP II.—Dogs 5, 6, 7 and 8 were re-operated upon at the end of sixty days. Fusiform neuromas were found at the central and distal lines of suture in Dogs 5 and 6 in which segments five and six centimetres long were removed and resutured. In Dogs 7 and 8 segments three centimetres in length were removed and resutured. These presented fusiform proximal neuromas and large bulbous distal neuromas. The dogs were killed after a second sixty-day interval and the nerves were removed for study.

Microscopical section of the distal neuromas resected at the second operation showed that in Dogs 5, 6 and 7 there was profuse branching of the fine neuraxons in the distal

end of the transplant. Many of them ended as spirals, or bulbs, and others entered the connective tissue at the distal suture line where they wound in and out in a tortuous pattern. Most of the neuraxes ended in the proximal portion of this connective-tissue mass, but a small percentage of them pierced through to the distal edge. Only a few of these neuraxons entered the distal segment of the nerve. In the neuroma removed from the three-centimetre transplant of Dog 7 the course of the neuraxes through the connective tissue was much straighter than in the other two, and a greater percentage reached the distal segment of the nerve. The neuroma removed from Dog 8 contained only connective tissue and no neuraxes. Both the transplant and the distal segment of the nerve showed evidence of complete degeneration.

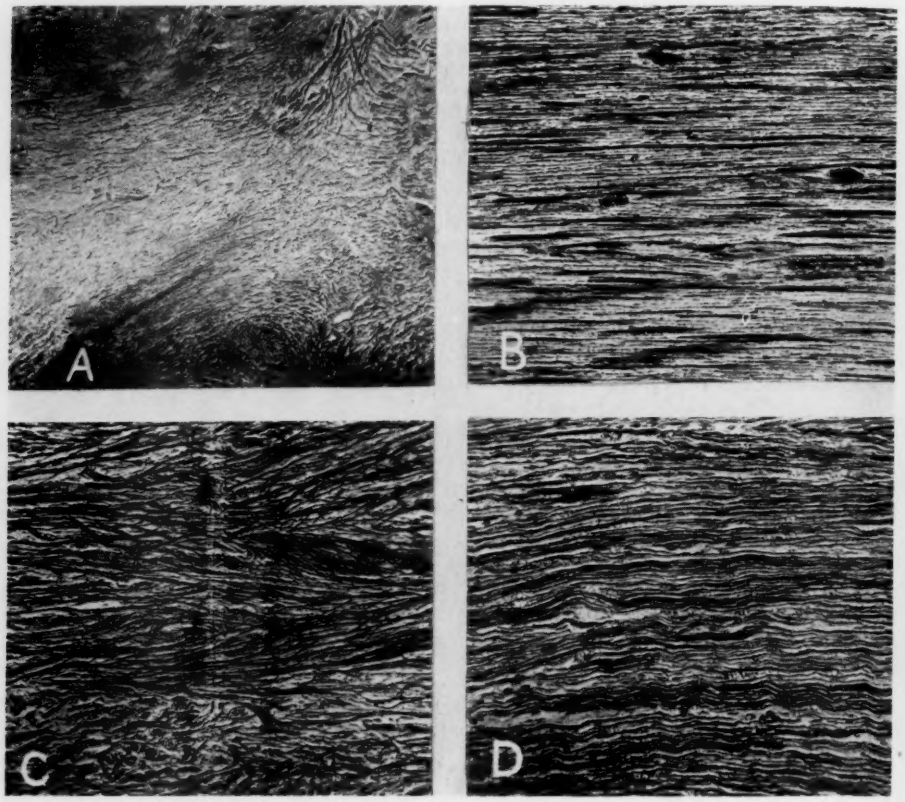


FIG. 3.—Microphotographs of (A), distal suture line seventy days after primary suture; (B), distal nerve segment seventy days after primary suture; (C), distal suture line seventy days after resection and resuture of distal end of the transplant and the distal segment of the nerve; (D), distal nerve segment seventy days after second suture. Note the large number of axones in the distal segment.

Microscopical sections of the nerve and transplant removed when the dogs were killed sixty days after the second operation revealed in each instance that connective tissue was less predominant at the distal suture line than in the primary distal neuromas, and the course of the neuraxes through this connective tissue was much less tortuous. At the distal line of suture the neuraxes branched in a synaptic manner, after which they again converged and followed a straight course to enter the distal segment of the nerve either in, or along, the protoplasmic bands of the degenerated nerve. The epineural sheath of the distal segment of the nerve was quite thick, and contained a heavy ingrowth of new connective tissue near the suture line, which diminished as the nerve was followed distally. (Fig. 2.)

GROUP III.—In this series of four animals, resection of the distal suture line neuroma was performed on the seventieth day after the first operation and in each case the distal suture line presented a bulbous swelling whereas the central line of suture was fusiform in shape. Sections of the resected distal neuroma showed that large numbers of fine neuraxons had grown through the transplant both intra- and extra-protoplasmically to reach a dense scar of connective tissue at the distal end. Many of the neuraxes ended in the distal end of the transplant while others gave off branches which entered the scar to take a very winding and tortuous course in the connective-tissue mass. Except in the neuroma removed from Dog 10, most of the fine neuraxons ended in the proximal portion of the scar where they grew in every direction, many of them curling back toward the central end. The distal segment of the nerve in each case was compressed tightly by connective tissue at the suture line and only a very few neuraxons had succeeded in growing into the distal portion of the nerve. In Dog 10 the transplant was three centimetres in length and a large number of neuraxons had grown entirely through the transplant and distal suture line into the distal segment of the nerve. The neuroma in this case was much smaller than in the other three of this group and the connective tissue less dense.

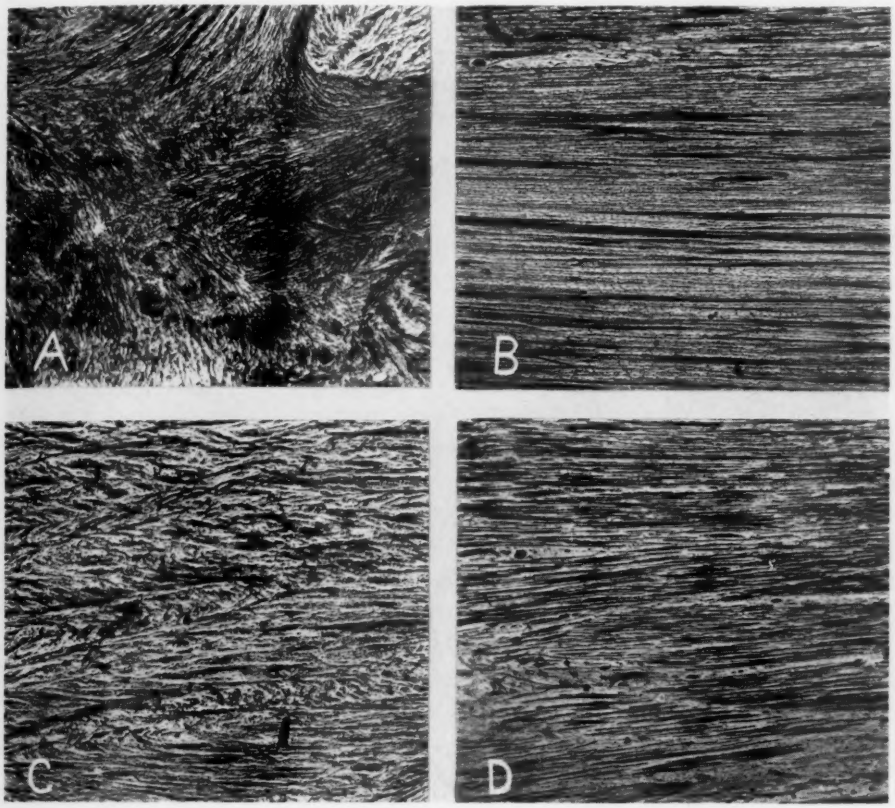


FIG. 4.—Microphotographs of (A), distal suture line eighty days after primary suture; (B), distal nerve segment eighty days after primary suture; (C), distal suture line eighty days after resection and resuture of distal end of the transplant and the distal segment of the nerve; (D), distal nerve segment eighty days after second suture.

Sections of the nerve and transplant removed when the dogs were killed seventy days after the secondary operation showed branching of the neuraxes in the distal portion of the transplant before they entered the connective tissue at the secondary distal suture

line. Beyond the suture line they converged to enter the distal segment of the nerve in a straight course. The number of regenerating nerve fibres was greater than the number of protoplasmic bands representing the degeneration that had preceded. (Fig. 3.)

GROUP IV.—Studies of the neuromas resected from the distal suture line eighty days after the introduction of the transplant in Dogs 13, 14, 15 and 16 showed that in each case the transplants had been entirely traversed by regenerating nerve fibres. In Dog 15 the transplant was three centimetres in length and the neuraxons had pierced the distal suture line and many had grown into the distal segment of the nerve. In the other three animals the majority of the neuraxes ended in the scar formed at the distal suture line and did not enter the distal segment of the nerve. The most central part of the distal segment of the nerve in each case was somewhat constricted by connective tissue and degeneration within the nerve was complete.

The sections of the nerve and transplant which were removed when the dogs were killed eighty days after the resection of the distal neuromas showed branching of the neuraxes in a fork-like manner as they entered the relatively small amount of connective tissue at the distal suture line. Their course became straighter and large numbers either entered or followed the protoplasmic bands in the degenerated portion of the distal segment of the nerve where they could be followed to the end of the sections. (Fig. 4.)

Comment.—We believe that these experiments show that the scar tissue formed between the distal end of the transplant and the end of the distal segment of the nerve during the time of growth of the neuraxons through the transplant may be a barrier through which the new nerve fibres cannot pass. We also believe that these experiments show very definitely that resection of this neuromatous barrier and resuture of the distal end of the transplant to the end of the distal segment of the nerve will permit continued downgrowth of the neuraxons into the distal segment of the nerve.

The clinical results obtained by surgeons in cases in which nerve transplants have been used and the experimental results of many investigators have been at variance. Perhaps one of the factors which has contributed to this difference in conclusions is the fact that experimental conclusions have been based mainly upon microscopical studies alone. Another factor which must be considered is the difference in the length of the transplant. On the ordinary laboratory animal only relatively short transplants can be used, whereas in humans it is in the large defects of nerve substance in which end-to-end suture is not possible that the surgeon resorts to the use of transplants. That the length of the graft plays an important part is borne out by our results, which were obtained in Dogs 14 and 15. In the first, a seven-centimetre section had been removed and a very solid scar had formed at the distal suture line. In the latter, a 3 three-centimetre transplant had been traversed by many neuraxons before a sufficient amount of connective tissue had grown at the distal suture line to block their further progress. It is obvious that sufficient time should elapse between nerve transplantation and the resection of the distal neuroma for the downgrowing neuraxons to reach the distal suture line. It is our observation that at least seventy days should elapse in a three-centimetre graft and, of course, in longer grafts a correspondingly longer time.

Although the number of cases are few, in which a nerve transplant is the only possible method of affording a chance of recovery of function, nevertheless large destructive wounds are encountered in civil life. It becomes a problem not only to find a nerve which can be sacrificed in sufficient length for use as a transplant without irreparable harm to the patient but to use a nerve the calibre of which is equal to that of the injured nerve. The latter naturally presents the greatest difficulty.

We have not as yet had occasion to do so, but it should be possible to use a homogeneous graft of the same nerve obtained under sterile conditions from a fresh autopsy specimen.* That a nerve transplant operation is not an emergency procedure makes this possible step a practical one. Our own few experiments with homogeneous grafts have been followed by histological results exactly similar to those we have obtained with autogenous grafts. Moreover, Huber's studies mentioned previously provide a sufficient basis for undertaking such a procedure. Certainly, the clinical results obtained with autogenous cable grafts have been so disappointing as to discourage further attempts to make practical use of them. Finally, nerve transplants have not been performed in any considerable number of cases under the ideal surgical conditions which are possible in civil life.

A careful examination of a large number of cases in which nerve transplants have been performed is necessary before any final conclusions can be reached as to the efficiency of this procedure. As has been stated before, in general, nerve transplants have not been followed by the degree of regeneration and functional recovery which we might have believed would occur as the result of animal experiments. The conditions under which many nerve transplants are performed, the lack of co-ordination between neurologist and surgeon, as well as the impossibility of re-examination over a long period of time serve to make many of the statistics in the literature valueless. Many of the available statistics were based upon the observations of individuals other than the surgeons who operated upon the patient. Not only is this true but often re-examinations have not been conducted over long periods of time by the same observer and recourse was had to questionnaires. That such conditions might lead to a divergence of opinion as to the value of nerve transplants might well be expected. The same criteria of a successful result must be employed even more critically in judging the results of nerve transplants than in the examination of functional recovery following end-to-end suture. For example, the return of a patient to work certainly cannot be used as an index of recovery and regeneration of nerve lesions in which supplementary motility is not carefully excluded.

*Since submitting this manuscript for publication, we have had an opportunity to use this method in the case of a patient who suffered an injury to the tibial nerve with a loss of substance. A four inch homogeneous graft of a sciatic nerve removed from a freshly amputated extremity was used. At the second operation, the graft was found to be in good condition. Sufficient time has not elapsed as yet to judge of the clinical results.

Further, it must be well recognized that the early return of protopathic sensibility in certain areas, or the shrinkage of analgesia may be due only to the assumption of function of adjacent uninjured nerves. Likewise, changes in the color or nutrition of the skin alone are valueless as indications of recovery of function.

CONCLUSIONS

(1) In nerve transplants the scar formed at the line of suture between the distal end of a transplant and the end of the distal segment of the peripheral nerve may act as an impenetrable barrier to the downgrowing neuraxons.

(2) Resection of this distal scar and resuture of the distal end of the transplant and the end of the distal segment of the peripheral nerve may allow continuation of the growth of the neuraxons into the distal segment of the nerve.

(3) Neuraxons may grow through a nerve transplant three centimetres in length to reach the distal line of suture at the end of sixty to seventy days.

BIBLIOGRAPHY

[1] Létiévant, J. J. E.: Traité des sections nerveuses. J. B. Baillière, et fils, Paris, 1873.

[2] Hoffmann: Einige Fälle von Nervenlähmung und Nervennaht. Mitt. a. d. chir. Klin., p. 118, Griefswald, 1884.

[3] Stookey, B.: Surgical and Mechanical Treatment of Peripheral Nerves; with a Chapter on Nerve Degeneration and Regeneration by G. Carl Huber. Saunders, Philadelphia, 1922.

[4] Pollock, L. J., and Davis, L.: Peripheral Nerve Injuries. Paul B. Hoeber, Inc., New York, 1933.

[5] Tillmanns, H.: Ueber die operative Behandlung von Substanzverlusten an peripheren Nerven. Arch. f. klin. Chir., vol. xxxii, pp. 923–946, Berlin, 1885.

[6] Mackenzie, J. A. J.: Resection of the Sciatic Nerve; Neuroplasty; End-results. Surg., Gynec., and Obst., vol. ix, pp. 9:30–44, Chicago, 1909.

[7] Stookey, B.: The Futility of Bridging Nerve Defects by Means of Nerve Flaps. Surg., Gynec., and Obst., vol. xxix, pp. 287–311, Chicago, 1919.

[8] Huber, G. C.: A Study of the Operative Treatment for Loss of Nerve Substance in Peripheral Nerves. Jour. Morphol., vol. xi, pp. 629–740, 1895.

[9] Assaky, G.: De la suture des nerfs à distance. Arch. gén. de méd., vol. xvii, pp. 529–553, Paris, 1886.

[10] Gluck, T.: Ueber neuroplastik auf dem Wege der Transplantation. Arch. f. klin. Chir., vol. xxv, pp. 606–616, Berlin, 1880.

[11] Flourens, P.: Expériences sur la réunion ou cicatrisation des plaies de la moelle épinière et des nerfs. Ann. d. Sc. Nat., vol. xiii, pp. 113–122, 1828.

[12] Philipeaux, J. M., and Vulpian, A.: Les essaes de greffe d'un troncon de nerf lingual entre les deux bouts de l'hypoglosse. Arch. de physiol. norm. et path., vol. iii, p. 618, Paris, 1870.

[13] Langley, J. N., and Anderson, H. K.: The Union of Different Kinds of Nerve Fibers. Jour. Physiol., vol. xxxi, pp. 365–391, London, 1904.

[14] Boeke, J.: Die Regenerationserscheinungen bei der Verheilung von motorischen und rezeptorischen Nervenfasern. Arch. f. d. ges. Physiol., vol. cli, pp. 57–64, Bonn, 1913.

[15] Mayo-Robson, A. W.: Nerve Grafting as a Means of Restoring Function in Limbs Paralyzed by Gunshot or Other Injuries. Brit. Med. Jour., vol. i, p. 117, London, 1917.

[16] Sherren, J.: Some Points in the Surgery of the Peripheral Nerves. Edinb. Med. Jour., n. s., vol. xx, pp. 297–332, 1906.

[17] Nageotte, J.: Sur la greffe des tissus morts et en particulier sur la réparation des pertes de substance des nerfs à l'aide de greffons nerveux conservés dans l'alcool. Compt. rend. Soc. de biol., vol. lxxx, pp. 925–933, Paris, 1917.

[18] Jiuanu, A.: Die chirurgische Behandlung der Facialislähmung. Deutsche Ztschr. f. Chir., vol. cii, pp. 377–386, Leipzig, 1909.

[19] Cajal, S. R., and Ramon, Y.: Degeneration and Regeneration of the Nervous System. Oxford Univ. Press., 2 vols., London, 1928.

[20] Huber, G. C.: Transplantation of Peripheral Nerves. Arch. Neurol. and Psychiat., vol. ii, pp. 46 –480, Chicago, 1919.

[21] Dujarier, C., and Francois: Sur 20 cas de greffe homoplastique dans les sections nerveuses. Bull. et mem. Soc. de chir. de Par., vol. xliv, pp. 43–47, 1918.

[22] Huber, G. C.: Operative Treatment of Peripheral Nerves after Severance, More Particularly after Loss of Substance; a Critical Review. Jour. Lab. and Clin. Med., vol. ii, pp. 837–848, St. Louis, 1916–1917.

[23] Verga, G.: Results of Operations on Peripheral Nerves. Inter-Allied Confer. After-Care Disabled Men, vol. ii, pp. 441–443, London, 1918.

[24] Ingebrigtsen, R.: A Contribution to the Biology of Peripheral Nerves in Transplantation. Jour. Exper. Med., vol. xxii, pp. 418–426, 1915; vol. xxiii, pp. 251–264, 1916; Lancaster, Pa.

[25] Depage, A.: Les interventions sur les nerfs périphériques et leurs suites éloigées. Arch. de méd. et pharm. mil., vol. lxix, pp. 297–304, Paris, 1918.

[26] Gosset, A.: Resultats fonctionnels des opérations faites sur les nerfs périphériques. Arch. d. méd. et pharm. mil., vol. lxix, pp. 304–340, Paris, 1918.

[27] Joyce, J L.: A Study of a Series of Peripheral Nerve Injuries from a Surgical Aspect. Brit. Jour. Surg., vol. vi, pp. 418–457, Bristol, 1918–1919.

[28] Stopford, J. S. B.: The Treatment of Large Defects in Peripheral Nerve Injuries. Lancet, vol. ii, pp. 1296–1927, London, 1920.

[29] Platt, H.: On the Results of Bridging Gaps in Injured Nerve Trunks by Autogenous Facial Tubulization and Autogenous Nerve Grafts. Brit. Jour. Surg., vol. vii, pp. 384–389, Bristol, 1919-1920.

[30] Platt, H., and Bristow, W. R.: The Remote Results of Operations for Injuries of the Peripheral Nerves. Brit. Jour. Surg., vol. xi, pp. 535–567, Bristol, 1923–1924.

[31] Lexer, E.: Plastischer Ersatz von Gesichtsdefekten. Deutsche med. Wchnschr., Berlin and Leipzig, vol. xxxiv, p. 1037, 1908.

[32] Foerster, O.: Die Schussverletzungen der peripheren Nerven und ihre Behandlung. Ztschr. f. orthop. Chir., vol. xxxvi, pp. 310–318, Stuttgart, 1916–1917.

[33] Stookey, B.: The Futility of Bridging Nerve Defects by Means of Nerve Flaps. Surg., Gynec., and Obst., vol. xxix, pp. 287–311, Chicago, 1919.

[34] Lewis, D.: Some Peripheral Nerve Problems. Boston Med. and Surg. Jour., vol. clxxxviii, pp. 975–984, 1923.

[35] Delangénière, H.: A Contribution to the Study of the Surgical Repair of Peripheral Nerves; Based on 375 Cases. Surg., Gynec., and Obst., vol. xxxix, pp. 543–553, Chicago, 1924.

[36] Tinel, J.: Nerve Wounds; Symptomatology of Peripheral Nerve Lesions Caused by War Wounds. London, 1917, 4°.

[37] Bunnell, S.: Repair of Nerves and Tendons of the Hand. Jour. Bone and Joint Surg., vol. x, pp. 1–26, Boston, 1928.

[38] Ballance, C. A., and Duel, A. B.: The Operative Treatment of Facial Palsy by the Introduction of Nerve Grafts into the Fallopian Canal. Tr. Am. Otol. Soc., vol. xxi, p. 288, 1931.

FURTHER EXPERIENCE IN THE RELIEF OF PAIN BY SECTION OF THE RAMI COMMUNICANTES AND GANGLIONATED SYMPATHETIC CORD

By Francis A. C. Scrimger, M.D., F.R.C.S. (C.)
of Montreal, Canada

In 1929, I presented before the surgical section of the New York Academy of Medicine a paper based on the behavior of two patients suffering from abdominal pain in whom no gross abdominal disease could be demonstrated. The pain associated, with typical hyperæsthetic zones of the Head type, was in each instance relieved by section of the sympathetic rami communicantes at the appropriate levels. To these I add two other cases recently observed and operated upon, together with a report on the subsequent history of the earlier cases.

It is surprising to realize how little interest, comparatively speaking, is taken by the average surgeon largely concerned with abdominal disease in the accurate understanding of pain perception in visceral disease or in the visualization of the afferent paths from the sympathetic by which pain must be perceived. More particularly for a rationalized treatment, a knowledge of the pain paths is much to be desired in patients suffering visceral pain where no gross disease can be demonstrated or when the disease is of such a nature that the removal of the cause of pain is not possible.

In an earlier paper I pointed out, as is well known, that the acuteness of perception and pain varies greatly with the individual and varies in the same individual under different circumstances of health and more especially of attention.

It will not be surprising to find that in most instances the patients showing these signs and suffering these pains are of the hypersensitive type and have concentrated on their disease; that they do so should not shut them out from our sympathy. It is difficult to compress into reasonable space the diverging and contradictory views held regarding the perception of pain, and its by-product, referred pain; but no small part of the interest of these two case reports rests on the evidence they furnish of the paths of pain through the sympathetic into the spinal columns. We have, perhaps, thought of the autonomic nervous system as more apart from and different from the cerebrospinal than is the case. This has, I think, hampered our understanding and made us slow to realize that the method of perception of afferent impulses from the viscera is not essentially different from our perception of afferent impulses through the somatic nerves. It is true that the stimuli setting up these impulses are somewhat different and that where the usual surface pain stimuli are pinching or cutting, the stimuli to which the autonomic system is sensitive are hypercontraction or distention.

If we look to its origin, Remak, in 1847, and Balfour, in 1877, pointed out that the autonomic is derived from the cerebrospinal. The investigation of Anodi, His and Marshall added further evidence, and Froriep, in 1907, demonstrated that cells of spinal origin advanced along the ventral roots and entered the primordia of the sympathetic trunks. Kuntz, beginning in 1909, showed first that the autonomic ganglia held the same relationship to the cerebrospinal nervous system in all vertebrates and that they arise from cells of cerebrospinal origin, which are displaced peripherally along the dorsal and ventral roots of the spinal nerves. Some of the cells of the same origin advance beyond the primordia of the sympathetic trunks and give rise to the pre-vertebral sympathetic plexuses. Kuntz further states that as early as fibres can be observed in the communicating rami, they are accompanied by cells identical with those in the sympathetic primordia. These cells are of the same character as are present in the spinal-nerve trunks and the majority of those which deviate from nerve trunks along the paths of the rami enter the sympathetic primordia. Ganfinni has also described the communicating rami in early mammalian embryos as a cellular structure. In origin, therefore, the sympathetic is not different from the somatic.

It is not necessary to describe the various divisions of the sympathetic but certain characteristics stand out. The anatomical arrangement of the afferent supply of the viscera is not basically different from that which obtains in the skin. The cell body of the afferent neuron lies in a dorsal root ganglion. Its peripheral process runs to the structure innervated, its proximal to the neuraxis. The efferent fibres, with only two known exceptions, the carotid body and the carotid sinus, consist of pre- and post-ganglionic fibres. The pre-ganglionic fibres of the efferent system have their cell bodies in a column of cells in the lateral horn. The fibres make their exit from the cord in company with the somatic fibres of the ventral root. They then leave the ventral root, turn forward, and enter a sympathetic ganglion. Such a nerve trunk is called a white ramus; but the white ramus carries also afferent fibres which enter the cord by the dorsal roots and connect with probably the normal pain columns of the cord.

From the ganglionated cord in addition to other branches come fibres which join the spinal nerves for the innervation of the visceral structures in the domain of that nerve. Such a branch is non-medullated and is the gray ramus. There is great divergence of opinion as to whether the afferent pain paths pass to the cord wholly by the posterior roots, or, as claimed by Lehman, Foerster and others, also by the anterior roots. This is an important point. If pain conduction is wholly by the posterior root, it is possible to interrupt this path completely and in appropriate cases to control pain by cutting a sufficient number of dorsal roots. If, further, the visceral pain paths reach the posterior root wholly through the white rami, it should be possible to control painful sensations by cutting these rami, provided sufficiently accurate formation can be found to localize the point of stimulus. It is in this connection that the cases here reported are of interest.

The question whether pain conduction is wholly by the dorsal roots is ably discussed in a recent paper by Davis, who feels forced to the conclusion that if sufficient dorsal roots are cut, all sensation, superficial and deep, all afferent impulses, somatic and sympathetic, are abolished. The apparently contradictory evidence may be explained by a far wider occurrence of overlap than is generally conceded; such, for instance, as occurred in a patient operated upon recently by Doctor Cone. The 1–6 dorsal roots were severed on the left side with a corresponding anæsthesia, disappearance of pain, and heat changes with sweating. At the same time the first dorsal root on the right side was cut and on subsequent examination no evidence of the section of this root could be made out. The knowledge of overlap is, of course, not new but the extent of it is not always taken into account.

Similarly, it should be possible to sever the afferent sympathetic paths if they can be shown to pass in wholly by the white rami, but it is well recognized that the afferent paths from an abdominal viscera may pass in by any one of several rami or even by several rami. It is here that the location of the referred pain may be useful. It has been taken that the referred pain in the skin, the Head zone, which has been held as a necessary symptom, does indicate the level of the sympathetic irritation, on the supposition that the area of hyperæsthesia in the skin to normal stimuli represents an inflowing sympathetic irritation of corresponding level, making the dorsal pain column so irritable that normal skin contact is perceived as pain. This pain may theoretically be blocked by interrupting the somatic nerve, to cut off the normal stimulus to the skin, which is perceived as pain; or by interrupting the afferent paths of the sympathetic which on this hypothesis is causing the dorsal pain columns to be hypersensitive. Ross MacKenzie and Head all subscribe to the view that visceral disease sets up a focus of irritability in the cord and sensory impulses passing into this are exaggerated into pain.

I shall not detail the histories of the two earlier cases; their interest lies at present in the fact that in both the pain was relieved by severing the white rami alone. In the first, operated upon in 1926, the tenth, eleventh, twelfth and first lumbar were cut and her pain was entirely relieved at the time. Since then she has had various distresses, she has had two subsequent operations; one for the removal of the uterus and the other a removal of the gall-bladder; but what she designates as "the old pain" has not recurred. She has been able to do her work and live a normal life. There is no hypersensitive area. The second case, operated upon in 1927, had a section of the rami from the ninth, tenth, eleventh and twelfth dorsal, had had some return of pain from time to time up to 1929. She was recalled in 1932 for examination; she has been able to do her housework; has not had any return of pain for nearly a year and there is no area of hyperæsthesia.

In the cases here reported, both complained of pain, one on the right side and one on the left. The right-sided pain had been present with varying, but increasing, severity for eight years. It was referred to the right side of the abdomen and back. It was associated with an area of hyper-

æsthesia in the distribution of the tenth and eleventh dorsal nerves. The hyperæsthesia was markedly definite in outline—it stopped abruptly at the mid-line. Nupercaine was injected opposite the tenth intervertebral foramen but forward on the bodies of the vertebræ so as to catch the sympathetic ganglionated cord but not the intercostal nerve. This resulted in two interesting observations: For a period of six hours the pain disappeared—the area of hyperæsthesia disappeared but normal sensation was maintained over the hyperæsthetic area. One must conclude that the blocking of the sympathetic resulted in the relief of the pain. That the sympathetic was blocked was indicated by the disappearance of the goose-flesh pilonidal phenomena over the area, which had been hyperæsthetic. That is, the efferent paths, the gray ramus, from the ganglionated cord to the somatic ramus was blocked. There were no changes in superficial heat as tested by the thermocouple.

During the operation the white rami were displayed passing to the ninth, tenth, eleventh and twelfth dorsal roots. This led to the ganglionated cord. The cord was severed below the eleventh and above the tenth. The ramus to the twelfth was cut, as also the ninth. Stimulation of the ganglionated cord now produced the goose-flesh appearance and a slight reddening of the skin in the corresponding skin areas. The ganglionated cord and at least two ganglia were removed in addition to cutting the rami from the ninth to twelfth segments. The pain did not return nor has it up to the present. The area of hyperæsthesia disappeared. The patient did complain of a good deal of pain and soreness in the back, much more than when the rami alone were cut. This was thought to be due to the removal of the posterior ends of the ribs.

The patient with the pain on the left side was a young, highly emotional woman. The distribution of the pain was in the left abdomen and in the back on the left side. The hyperæsthesia was extreme, so that even a motion towards the area resulted in a shrinking away. The relief from nupercaine was of a shorter duration but associated with the same disappearance of the hyperæsthesia and retention of normal sensibility. There was here also disappearance of the pilonidal reflex but no heat change. It can, I believe, be said that in these two instances also, abdominal pain together with an area of hyperæsthesia has been relieved by interruption of the sympathetic afferent paths.

The case reports are as follows:

CASE I.—Miss G. First admission, May 13, 1931. Pain in back and twitching on left side. Pain when she lies on her right side. The main complaint is pain in the left side into the groin and across the lower abdomen. This started March 1. It was at first a twitching of the muscles. She had some nocturia and trembled under any emotional strain. There is a history, three years earlier, of sharp pain suggesting renal calculus. Examination at this time revealed no definite disease. *Diagnosis.*—Neurasthenia. Blood chemistry normal. Heart and lungs normal. Gall-bladder normal. X-ray of intestinal tract showed colonic stasis. Genito-urinary tract normal.

Re-admitted December 14, 1932. Since discharge she has had the same pain in the left side of the abdomen and back, becoming worse. Said to have had blood in

the urine on occasions. Tenderness in left side of abdomen and pain—otherwise as before—all examinations repeated. Pyelogram shows a slightly dilated renal pelvis. January 9, 1933, the patient was seen by Doctor Scrimger, who noted an area of hyperæsthesia in the distribution of the eleventh dorsal nerve. Consultation with the Orthopaedic Service, Doctor Turner, found no disease of the spine or sacro-iliac joints.

January 18, 1933, seen by Doctor Cone of the Neurological Surgical Department, who confirmed the area of hyperæsthesia. Thirty cubic centimetres 1/1500 nupercaine were injected below the ninth rib; the pain diminished but the hyperæsthesia area remained. Twenty cubic centimetres were injected against the body of the vertebra, a segment lower, and the area of hyperæsthesia disappeared and the pain was relieved. Normal sensation remained. Temperature tests of skin with thermocouple revealed no notable change. Goose-flesh reaction could be brought out down to but not over the area which had been hyperæsthetic. The relief of pain and loss of hyperæsthesia lasted only three to four hours. Pain then returned as before. January 31, 1933, area of hyperæsthesia marked out and photographed.

Operation.—Sympathetic ganglionectomy. Incision over vertebral spines from ninth to twelfth dorsal. The muscles were pushed to the lateral side until the transverse processes were exposed. The transverse processes of the tenth and eleventh vertebræ were chiseled off close to the body of the certebra. The tenth and eleventh ribs were then cleared and removed from about one and a half inches of the medial end up to the articulation with the vertebræ. The intercostal nerves of the ninth, tenth and eleventh were dissected free and the white rami communicantes isolated. The dissection was then carried forward over the body of the vertebra until the ganglionated cord was exposed, into which the white ramus of each segment could be seen entering. The sympathetic cord was then cut below the ganglion corresponding to the eleventh and below the ganglion corresponding to the ninth. The white ramus was in each case cut but the communication to the ganglion corresponding to the tenth and the eleventh was left intact.

At this point electrical stimulation of the nerve of the ganglionated cord was made, with a current sufficiently strong to produce a definite muscular reaction. On the left side of the abdomen corresponding to the area of hyperæsthesia there was observed during the stimulation a goose-flesh phenomenon and a slight change of color towards hyperæmia. The changes were not very marked but were considered to be present. The ganglionated cord was then removed. The portion removed included the ganglia corresponding to the eleventh and tenth with a portion of the cord above and below and the white rami of the ninth, tenth, eleventh and twelfth. The wound was then closed.

Following the operation the area of hyperæsthesia disappeared and the pain in the abdomen was relieved. She complained of a great deal of pain in the back on respiration but gradually this subsided. The objective evidence of hyperæsthesia and goose-flesh phenomenon have remained absent to the present date. She is relieved of pain in the abdomen but still complains of pain in the back.

Case II.—Mrs. R. Ch., forty-three. History of pain dating back for eight years. The onset was with pain in the region of the right kidney. She was told that the right kidney was enlarged and some operation on the urethra was performed. She was then free from pain for nearly four years, when she received an injury and the right side was swollen and bruised. The pain in the kidney region returned and a diagnosis of pelvic infection was made. This subsided after some months but the pain in the right kidney returned, accompanied by some frequency. There was here also a history, not supported by observation, of some blood in the urine.

The pain has continued and she has been unable to wear her clothing or do her work. Except for the pain and tenderness on the right side of the abdomen, the ordinary examination revealed nothing abnormal. Special examination proved a normal urine and kidney. Specialist's examination of pelvis was reported normal. Barium meal and enema showed no disease. On examination of the abdomen an area of local-

ized hyperæsthesia was found corresponding to the pain. As in the previous case an injection of nupercaine to block the sympathetic ganglionated chain resulted in the disappearance of the hyperæsthetic area and relief of pain for seven hours without loss of normal sensation over the previously hyperæsthetic area.

February 10, 1933, a ganglionectomy with ramisection was performed. The steps for the operation were exactly as in the previous case. The transverse processes of the tenth, eleventh and twelfth vertebræ were removed together with the posterior one and a half inches of the corresponding ribs. The white ramus of the ninth, tenth, eleventh and twelfth segments was isolated and traced forward to the ganglionated cord. The cord was cut below the eleventh and below the ninth, these rami being still intact. Stimulation by faradic current of the cord resulted in a definite goose-flesh phenomenon in the previously hyperæsthetic area and a slight reddening of the skin. The rami of the ninth, tenth, eleventh and twelfth were severed and at least two ganglia removed, the tenth and eleventh. As before the hyperæsthetic area became normally sensitive and the pain was relieved.

As before, a good deal of pain was complained of in the region of the wound. The pain and hyperæsthesia have not returned at the time of reporting.

SYPHILIS OF THE CLAVICLE

By Francis M. Conway, M.D.
of New York, N. Y.

FROM THE SURGICAL SERVICE OF THE HARLEM HOSPITAL, DR. JOHN F. CONNORS, DIRECTOR

The presentation of this subject from the Surgical Service of the Harlem Hospital was stimulated by the occurrence of three cases of luetic involvement of the clavicle which were admitted to the service following minor injuries to that part. On our service many fractures of the clavicle come under observation. The unusual character of the radiographs of these cases and the response to specific therapy were so pronounced that a review of the lesion was considered timely.

In an age when syphilis receives careful attention, where the Wassermann reaction is employed routinely and where specific therapy is readily instituted, the incidence of gummata of bones is rapidly diminishing. These facts, combined with the observation that luetic involvement of the body of the clavicle is in itself an uncommon finding, make its existence even more unusual. In this discussion, we are not concerned with the luetic involvement of the sternoclavicular articulation which has been seen with sufficient frequency to warrant a suspicion as to the diagnosis by inspection. The cases which are herein described are those which involve the corpus of the clavicle. In the first case, we have the type referred to as the osteoperiosteal type, the radiograph of which has frequently been mistaken for an early Paget's disease, a bone sarcoma or a secondary bony metastatic deposit. (Fig. 1.) The second and third cases are of interest to the traumatic surgeon because of the fracture occurring in the bone previously damaged as the result of syphilitic involvement. (Figs. 4 and 5.)

Etiology and Pathogenesis.—With the tibia, the radius, sternum and frontal plate of the skull, the clavicle is one of the sites of predilection of bone syphilis. This fact is easy to understand when one takes into account the effect of trauma on patients of luetic diathesis. The clavicle is, in fact, one of the bones where fracture, either spontaneous or traumatic, is easily facilitated. Its shape as an italicized "S" exposes it, as we know, to direct violence and at the same time being fixed between sternum and shoulder girdle it is at the mercy of traumata which may be received on the upper extremity. Therefore, the bone, by virtue of its position, form and superficiality, is exposed without any muscular protection to all forms of external violence. Hunter, Virchow and Cornil demonstrated that minor traumata are sufficient to call forth luetic bony manifestations at points of contact.

As regards its incidence, Jullien, in sixty-four cases of gummata of bone, reported the following:

Nose	19	Os frontale	1
Tibia	15	Os parietal	1
Palate	15	Vertebræ	1
Sternum	5	Scapula	1
Clavicle	4	Patella	1
Maxilla	4	Bones of forearm	1

There are three distinctive stages which may present themselves with osseous syphilis: (1) Simple osteoperiostitis; (2) osteoperiostitis and

FIG. 1.—(CASE I.) Syphilitic involvement of the left clavicle of the osteoperiosteal type showing at (a) the typical vacuolization in an area of gummatous osteomyelitis. The middle portion of the corpus of the clavicle shows a moth-eaten appearance with destruction of the normal contour of the bone and at the points marked (b) and (c) there are definite exostoses. Radiograph shows many of the characteristics of both tuberculosis of the clavicle and sarcoma of the clavicle, from which a differential diagnosis must be made.

gummatous osteomyelitis; (3) hyperostotic form of lues. As corollaries of these states we have exostoses, necrosis, and spontaneous fractures.

The causes and the mode of production of these spontaneous fractures present a real interest. Under the title of spontaneous fracture is meant all fractures which occur as the result of a morbid alteration in the bone

itself which follows a slight trauma quite insufficient to injure a healthy bone.

(1) *Periostitis and Osteoperiostitis.*—The periostitis is caused by a true primary vascular change. This swelling interferes with the bone causing the characteristic pain. The osteoperiostitis is an extension of the disease into the Haversian canals. These inflammatory processes may end by resolution, especially under treatment, or they may progress to a rarefying osteitis or a proliferating osteitis (Fig. 1), the latter causing an eburnation or formation of osteophytes or exostoses. The rarefying osteitis progresses by destroying the walls of the Haversian canals and produces a spongy condition of the bone which may or may not be filled up by bone proliferation. Should bone proliferation not occur, then necrosis results and we come to the stage of gummata.

(2) *Gumma.*—Gumma, which is the typical lesion of the tertiary luetic state, is the end-result of the proliferative stages of the inflammatory period. These may be periosteal, subperiosteal, osseous or osteomyelitic.

(3) *Hyperostotic Form of Lues.*—The third group of cases referred to as the hyperostotic form of bone syphilis was quite completely described by Hahn and Deycke[25] in their presentation of the manifold radiographical peculiarities of delayed congenital and acquired syphilis. Anatomically and radiologically, the purely osteoplastic bone lesions form a particular and characteristic group. They occur either as circumscribed tophi or as diffuse hyperostoses of the long bones. This form is less common than the gummatous form and may occur both in delayed congenital or acquired syphilis. In contrast to the gummatous form, the soft parts are *not* involved in the diffuse hyperostotic type of bone lues.

In an enumeration of these three groups of luetic involvement it must be understood that they are not quite distinct and separate entities. They are different stages of the same pathological condition and perhaps might better be regarded as demonstrating the "proliferative" and "degenerative" phases of one process. The "proliferative stage" or "periostitis" is the precursor of the "degenerative" type. There may often be seen evidence of the evolution of such a process in different bones of the same individual, and when intensive treatment is administered the lesion becomes retrograde in appearance (*viz.,* Case I, plate 2 *vs.* 1.) with the degenerative bone increasing in density and returning to the proliferative stage or periostitis. In the visualization of bone lues various processes are often coexistent but the order of evolution is in a general manner the same.

Laporte,[12] in his Thesis, gives the following review of cases of spontaneous fractures which he was able to obtain from the literature—all of which resulted from trivial injuries.

Symptomatology.—There are two never-failing signs of bone involvement, namely: pain and tumefaction. The symptom of pain varies but often may be intense and lancinating. It is usually more pronounced at night. The more superficial the bone the more apt is tumefaction to be found. With our cases pain and swelling were pronounced. In the first case (S. M.)

Spontaneous Fractures of Clavicle

Case Reports (from Laporte)

Author	Sex	Age	Clavicle	Site	Immediate Cause	Treatment	Result
Walther.....(1820)	F.	46 yrs.	Left	Body	Turned in bed		Pseudo-arthrosis
Delpech.....(1823)	M.	Adult	Left	Body	Put on vest	Mercury	Rapid improvement
Rimaud.....(1830)	M.	Adult	Left	Body	Raised arm		Pseudo-arthrosis
Santucho.....(1840)	M.	60 yrs.	Left	Body	Mounted horse	by	?
Venot.....(1847)	F.	28 yrs.	Left	?	Put on coat	mouth	Rapid improvement
Chassaignac.....(1854)	F.	40 yrs.	Right	Sternal	Lifted pump handle		Necrosis
Geissler.....(1862)	F.	40 yrs.	Right	?	Folded arms	and	Rapid improvement
Delens.....(1875)	M.	40 yrs.	Right	Body	Raised table		?
Patey.....(1878)	F.	43 yrs.	Right	Body	Raised cover of bed	by	Pseudo-arthrosis
Dreschfeld.....(1881)	M.	36 yrs.	Right	Sternal	?		Rapid improvement
Berkeley Hill.....(1881)	F.	6 wks.	Right	Body	?	in-	Rapid improvement
Bouilly.....(1881)	F.	34 yrs.	Left	Body	?		Necrosis
Breda.....(1884)	F.	57 yrs.	Left	Body	?	unction	Rapid improvement
Kirmisson.....(1889)	M.	44 yrs.	Left	Body	Fell (contrecoup)		Rapid improvement

Subjects: 7 female, 6 male, 1 child. *Sites:* 10 body, 2 sternal, 2 unknown. *Causes:* Insignificant traumata. *Results:* 7 rapid improvement, 3 pseudo-arthrosis, 2 necrosis, 2 not followed.

the swelling appeared without any history of definite trauma and the pain in the clavicular swelling was not especially noteworthy for its intensity.

Osteoperiostitis of the clavicle may appear in a very precocious manner and its onset may be characterized by nothing more than vague pains and a slight clavicular puffiness without any localized swelling. The site of the lesion, in order of its frequency, is said to be most frequent along the anterior border or superior face of the body and less frequent at the acromial end of the bone.

The swelling itself may be large or small but is generally fusiform in outline and with its axis in the direction of the clavicle. Suppuration, when it occurs, is usually only slight in amount. With our second case, the immediate trauma was nothing more than an attempt to forcibly open a closed door. This slight exertion produced a fracture and the condition of the previously diseased clavicle may be seen in Fig. 4.

Diagnosis.—Four factors are preëminent in the establishing of the diagnosis, and they are (1) history, (2) radiograph, (3) serological reaction, and (4) response to specific therapy.

By history is indicated not only the history of initial infection where possible to elicit this, but the absence of any unusual trauma or accident to the clavicle. Suspicion of clavicular lues is always aroused when a painless swelling of the clavicle is noted without any noteworthy trauma.

The radiograph has proven invaluable in the diagnosis, not only because of early recognition but also because of its demonstrating the repair processes occurring after the institution of specific therapy. A myriad of diverse röntgenological findings occur dependent entirely upon the stage of evolution of the process.

Two pertinent and outstanding facts should be noted; first, lues of bone is usually a constructive osteoplastic process and though we have observed various exceptions to this general statement, in the main it is true. Secondly, the extent of the recorded röntgen involvement in lues of bone is rarely paralleled by the clinical symptoms, the clinical findings not being as extensive as the radiographical evidences. This is not the fault of the clinician but the character of the disease.

Distribution may be localized in any part of the bone or diffuse throughout the bone. The first changes are more frequently apparent on the surface of the bone as a fuzzy proliferation of the periosteum, though occasionally the first evidence is a central opacity.

The periosteum may be arranged in strata with definite spacing between each layer. "Bone blisters" may occur with proliferation and elevation of the periosteum over a small area, coexistent with a destructive process, which may break through the periosteum, forming an umbilicated cavity in the cortex.

There may be a proliferation of the periosteum in the form of fine bone trabeculæ anastomosing and forming the so-called "lace work." The entire bone may be enlarged with massive increase in the size of the cortex and

gradual encroachment upon or obliteration of the medulla. The process may be intensified on one surface, giving the appearance of bowing of the entire bone. With the degenerative phase, a massive enlargement of the bone is noted with areas of increased opacity alternating with areas of destruction, but not atrophy. The densely hypertrophied periosteum is gradually encroached upon and destroyed by the degenerative process. In spongy bone, the destructive process is characterized by areas of increased opacity,

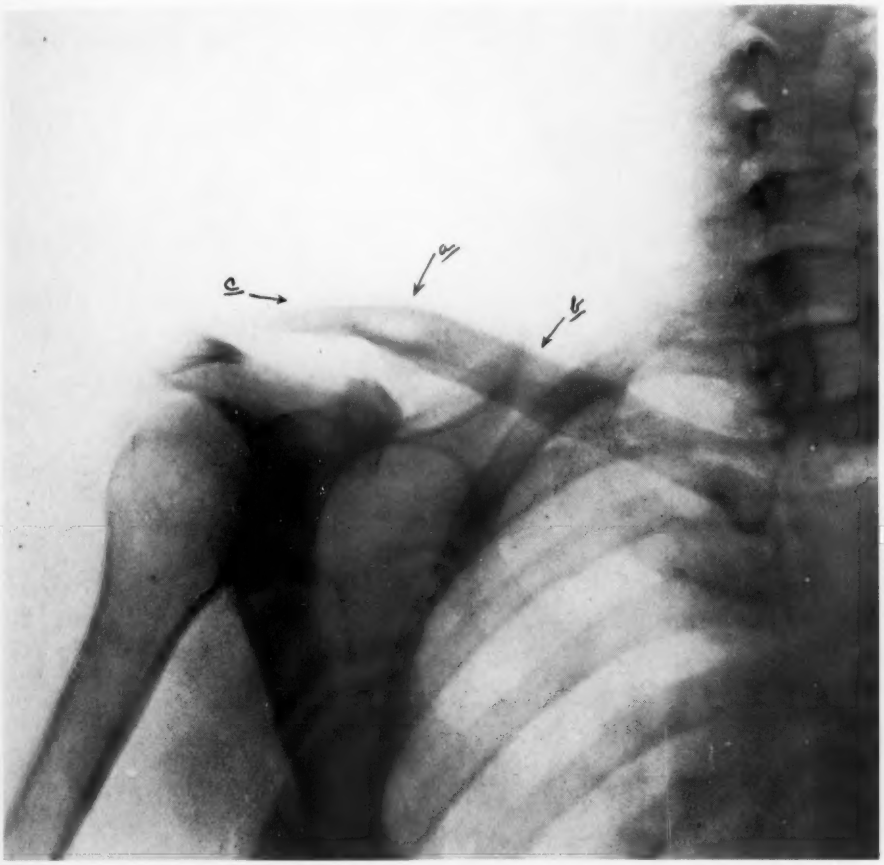


FIG. 2.—(CASE I.) Radiograph taken six months after institution of vigorous antiluetic treatment. The entire character of the process in the bone has changed and the normal contour of the clavicle is returning. At the point (a) there still remains a small vestige of the gummatous process seen in Fig. 1. At the point (b) periosteal thickening may now be detected, indicating the retrograde character of the disease in returning from the destructive to the proliferative phase. At the point marked (c) the bone has practically returned to its normal size.

obliteration of normal trabeculations and, on breaking through the surface, by the appearance of nodular masses. Atrophic changes do not occur as there is usually only slight impairment of function. This fact is in contrast with other bony affections where atrophy of adjunct parts results from disuse. Pathological fractures occur after extensive destruction and never in the early or proliferative stage, when the bone is even stronger than normally. The serological reaction which is invariably positive and the rapid ameliora-

tion of clinical symptoms following a course of antiluetic therapy are probably the most positive diagnostic features.

Radiographically, the changes are striking within a short period after the institution of treatment. Figure 1, which is the first radiograph of Case I (S. M.) shows the marked destruction of the corpus of the clavicle and Fig. 2 demonstrates the return to practically the normal contour of the bone.

With regard to the question of differential diagnosis, the desirability of

FIG. 3.—(CASE I.) The clavicle, taken seven months after the institution of antiluetic treatment, shows a diminution in the amount of periosteal involvement and a further return to the normal outline of the clavicle.

making repeated röntgenograms of the clavicle should not be overlooked to determine the effect of diagnostic therapy. The reaction of bone lues to proper therapy is usually rapid and as contrasted with tuberculosis of bone—this is striking. Sarcoma of the clavicle may be ruled out on this basis as well. From confusion with Paget's disease of the clavicle, which may pre-

sent many identical features of the hyperostotic form of osseous lues, the above-mentioned data are invaluable aids.

Treatment.—The routine of specific treatment of these cases will vary in different clinics and depend entirely on the preference of the individual treating them. The cases treated by mercurial inunction and intra-oral mercurials in France in the early nineteenth century were all reported as having been benefited by this method. We have given intravenous neoarsphenamine Gm. 0.45 at weekly intervals for eight weeks and this followed by weekly bismuth for ten weeks. The result of this régime was quite satisfactory, as may be seen in the radiographical plates as well as in the reported amelioration of the patient's symptoms.

CASE REPORTS

CASE I.—S. M., an adult colored woman of fifty, was admitted to the Surgical Service of the Harlem Hospital, April 6, 1932, with the complaint of an increasingly painful enlargement in the central portion of the left clavicle of ten days' duration. There was no history of injury and the patient had no recollection of having been struck in that region at any time. Physical examination disclosed a swelling of the left clavicle in the midcorpus about the size of a small lemon which was hard, tender, but was not warm to the touch. There was no indication of any inflammatory reaction involving the clavicle. Her past history was negative. Radiograph of the left clavicle (April 6, 1932) shows a most unusual appearance. The entire clavicle is the site of a morbid process which seems more advanced in the midcorpus. There are productive and destructive changes with some osteophytic formation. (Fig. 1.)

Blood Wassermann: 4 plus.

Diagnosis.—Luetic destructive process of left clavicle. Specific therapy was instituted May 5, 1932, as follows:

Neo. 0.45	*Bismuth*
1. 5/ 5/32	1. 7/13/32
2. 5/12/32	2. 7/27/32
3. 5/19/32	3. 8/ 3/32
4. 5/26/32	4. 8/17/32
5. 6/ 2/32	5. 8/24/32
6. 6/ 9/32	6. 9/ 7/32
7. 6/16/32	7. 9/14/32
8. 6/30/32	8. 9/21/32
	9. 10/26/32
	10. 11/30/32

At the end of three months, the external swelling of the clavicle had disappeared and the patient was described as being symptom-free. Follow-up X-ray taken November 2, 1932, shows almost a complete disappearance of the destructive process involving the left clavicle, though some periosteal thickening of the bone is still present. (Fig. 2.)

CASE II.—E. S., a colored woman of twenty-three years, was admitted to the Surgical Service of the Harlem Hospital October 14, 1932, with the history of having attempted to forcibly open a door on October 1, 1932, and following this strenuous manœuvre felt a sudden sharp pain in the region of the right clavicle. She noted shortly thereafter that a lump about the size of a lemon had appeared which was tender on palpation. The lump had gradually increased in size.

Past history negative except for usual childhood diseases; appendectomy 1916; gonorrhœa and lues denied. Family history negative. Patient married—no children, no

miscarriages. Physical examination negative except for the local surgical condition. There is an ovoid swelling involving the clavicle at the junction of the middle third and medial third which is tender and movement of the right arm causes pain at the site of the swelling.

Laboratory Data.—Urinalysis negative. Hemoglobin, 75 per cent.; red blood-cells, 4,370,000; white blood-cells, 11,000. Polymorphonuclears, 79 per cent.; lymphocytes, 21 per cent. Kahn, 4 plus.

X-ray No. 12634, taken October 8, 1932, showed a transverse fracture of the right

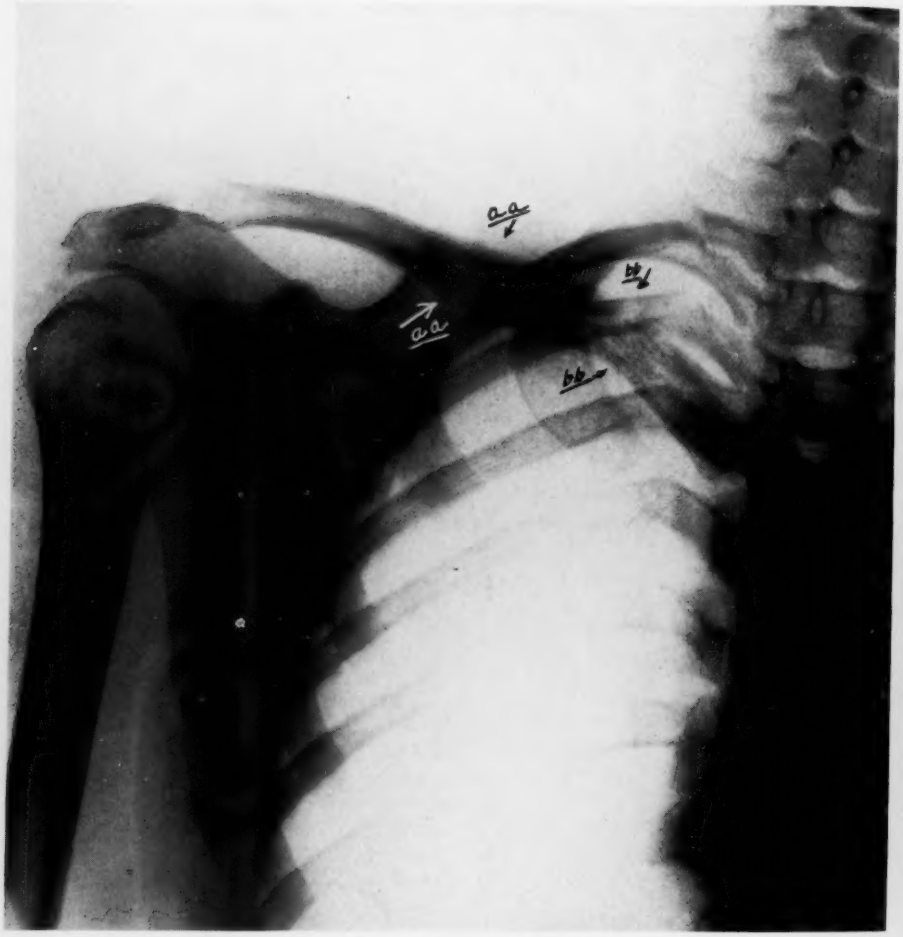


FIG. 4.—(CASE II.) Fracture through a luetic clavicle of the osteoperiosteal type. The point marked (aa) indicates the area of marked periosteal thickening and (bb) the site of fracture. In addition to this there is an associated subacromial bursitis with calcific deposits.

clavicle about four centimetres distal to the sternoclavicular articulation. Excellent position of fragments. There is rarefaction of the clavicle in the region of the fracture with increased periosteal reaction and thickening involving the distal part of the clavicle. In addition, several refractile bodies appear in the region of the subdeltoid bursa. (Fig. 4.)

Diagnosis.—(1) Syphilis of clavicle with pathological fracture. (2) Subdeltoid bursitis or luetic bursitis with refractile bodies.

CASE III.—M. B., a colored female of thirty years, was admitted to the Surgical Clinic of the Harlem Hospital with complaint of pain and swelling of the right clavicle of

six months' duration. The patient states that she does not remember having received any trauma to that region or having engaged in any strenuous exercise. Onset of pain followed the appearance of a swelling which at the present time is about the size of a small lemon.

Physical examination negative except for the right clavicle, in the midpoint of which is a rounded swelling about the size of a small lemon, firm and apparently attached to the clavicle.

First Wassermann reported as being negative but the second blood examination taken after a provocative injection of neoarsphenamine, Gm. 0.15, was reported as being 4 plus

Radiograph of the clavicle (Fig. 5) showed the clavicle thickened throughout its

FIG. 5.—(CASE III.) Fracture through a luetic clavicle of the osteoperiosteal type. Point marked (a) indicates the site of fracture and (b) the periosteal thickening of the corpus of the clavicle.

midcorpus with marked periosteal thickening. At the junction of the middle and proximal thirds, there is a fracture with excellent apposition of fragments. The clavicle is the site of a morbid process which gives an impression of being luetic in character.

Diagnosis.—Gumma of the clavicle with pathological fracture.

At the present time the patient is receiving antiluetic treatment in the form of intravenous neoarsphenamine and potassium iodide by mouth.

Conclusions.—(1) Three cases of luetic involvement of the clavicle are presented; two of which revealed pathological fractures.

(2) The lesion is not observed as frequently as formerly owing to the more widespread routine treatment of the disease. For this reason its existence is even more unusual.

(3) Diagnosis is made on the four criteria of history, X-ray, Wassermann, and reaction to specific therapy. The clinical symptoms are in no wise in proportion to the extent of the clavicular involvement.

(4) Differential diagnosis is to be made from sarcoma, tuberculosis and in the hyperostotic form of lues from Paget's disease of the clavicle.

(5) The response to specific therapy is striking and rapid and the value of the provocative dose of antiluetic treatment is to be emphasized.

BIBLIOGRAPHY

[1] Petit, J. L.: Traite des maladies des os. These Paris, vol. xi, pp. 116, 1732.

[2] Perret, Th.: Osteomyelite gommeuse diffuse de la clavicule droite. Autopsie. Th. Lyon, 1885.

[3] Chassaignac: Fract. Syphilitique de la clavicule droite. Bull. Acad. de méd., Paris, vol. xx, p. 449, 1854–1855.

[4] Bouilly: Fracture syphilitique de la clavicule gauche. Gaz. méd. de Paris, pp. 610–612, 1881.

[5] Rimaud: Deux cas de fract. spontanee de la clavicule. Fract. syphilitique. Th. Paris, 1839.

[6] Santucho: Fract. Syph. de la clav. Rev. méd., vol. cxi, No. 1, 1841.

[7] Santucho: Rev. méd. franç. et etrangere, vol. i, p. 395, 1841.

[8] Delens: Fract. syph. de la clav. droite, a sa parte moyenne. Arch. gen. de méd., p. 257, 1875.

[9] Berkeley Hill: Syphilis and Local Contagious Disorders. London, 1881.

[10] Breda: Fractura spontanea della clavicula sinistra da sifilide. Gior. ital. della mal. venere et della pelle. Anno, vol. xix, 1884.

[11] Venot: Accidents tertiares de la syphilis. Gaz. méd. de Paris, 2°s., vol. xi, p. 120, 13 fev. 1847.

[12] Laporte, Chas.: Syphilis de la Clavicule. Paris These No. 77, pp. 1–52, 1890.

[13] Schulman, Maximilian: Syphilis of the Sternum—2 case reports. Jour. Am. Med. Assn., vol. lx, pp. 515–516, February 5, 1913.

[14] Campbell, W. C.: An Analysis of Bone and Joint Lesions of Known Syphilitic Origin. Radiology, vol. v, No. 2, pp. 122–132, August, 1925.

[15] Wihelm, Seymour F.: Osteitis Fibrosa and the Hyperostotic Form of Bone Syphilis. Surg., Gynec., and Obstet., Chicago, vol. xli, No. V, pp. 624–639, November, 1925.

[16] Churchman, John W.: Luetic Bursopathy of Verneuil. Amer. Jour. of Med. Sci., pp. 371–396, September, 1909.

[17] Keyes, E. L.: Syphilis as Affecting the Bursæ. Amer. Jour. of Med. Sci., p. 349, 1876.

[18] Voisin: Contribution a l'etude des arthopathies Syphilitiques. Paris Thesis, 1874.

[19] Hutchinson, Jonathan: Osteitis Deformans and Syphilis. Med. Press, vol. cxv, p. 366, 1897.

[20] Fournier, A.: La syphilis hereditaire tardive. Paris, 1886.

[21] Skillern, P. G.: Syphilis in the Etiology of Fibrous Osteitis. Amer. Jour. Med. Sci., vol. cxiv, p. 531, 1913.

[22] Rebattu, Gate, *et al.*: Osteo-periostite syphilitique du carrefour sterno-claviculaire avec myosite interstitielle des chefs sternaux des muscles sterno-cleido-mastoidieus. Bull. Soc. franç. de dermat. et syph., vol. xxxix, pp. 4–5, January, 1932.

[23] Hazen, H. H.: Practical Observations on Syphilis. Amer. Jour. Syph., vol. vi, pp. 434–437, January, 1927.

[24] Hutchinson, Jonathan: Syphilis. Cassell & Co., London, 1887.

[25] Hahn, R., and Deycke, P.: Knockensyphilis im Roentgenbilde. Fortschr. a. d. Geb. d. Röntgenstr., vol. xiv, 1907.

ACUTE PANCREATITIS

By Cyrus F. Horine, M.D.

of Baltimore, Md.

from the department of surgery of the school of medicine of the university of maryland

The author reports, herewith, thirteen cases of acute pancreatitis treated at the University Hospital within the past ten years. Cases II and IX were treated by the author.

Male, five cases; female, eight cases. Average age, forty-three years. Glycosuria, one case; fat necrosis, nine cases. Average leucocyte count, 20,022. Gall-bladder disease, eight cases. Mortality, six deaths, or 46.15 per cent. Cases II, IX, X, cultures negative. Case II had associated suppurative appendicitis. Case IV had associated complete obstruction of ilium near cæcum. Case X had been ill for two days with alcoholism. Case XIII had been treated for more than one year for pernicious anæmia. Cases XII and XIII had "tight gall-bladder" but no definite gall-bladder pathology upon gross examination.

Table I.

Cases of Acute Pancreatitis

Case I.—(No. 63,443.) Mrs. E. R., aged fifty. Admitted, June 16, 1929. Duration of illness before admission—forty-eight hours. Blood chemistry—148 milligrams sugar before operation; 386 milligrams after operation. Glycosuria, positive. Fat necrosis, positive. Leucocyte count, not made. Gall-bladder disease, negative. Died.

Case II.—(No. 24,835.) H. D., aged forty-nine. Admitted, May 26, 1921. Duration of illness before admission—forty-eight hours. Blood chemistry, not taken. Glycosuria, negative. Fat necrosis—positive. Leucocyte count—25,800. Stones in gall-bladder. Cured.

Case III.—(No. 43,978.) Mrs. W. G., aged forty-three. Admitted, June 28, 1925. Duration of illness before admission—twenty-four hours. Blood chemistry, not taken. Glycosuria, negative. Fat necrosis—positive. Leucocyte count—16,650. Gall-bladder disease, negative. Cured.

Case IV.—(No. 32,318.) Mrs. M. B., aged seventy-one. Admitted, January 1, 1923. Duration of illness before admission—forty-eight hours. Blood chemistry, not taken. Glycosuria, negative. Fat necrosis—positive. Leucocyte count—19,700. Stones in gall-bladder. Died.

Case V.—(No. 63,810.) Mrs. A. W., aged sixty-three. Admitted, July 10, 1929. Duration of illness before admission—forty-eight hours. Blood chemistry, not taken. Glycosuria, negative. Fat necrosis—negative. Leucocyte count—28,100. Gall-bladder disease. Empyema. Died.

Case VI.—(No. 48,732.) Mrs. A. J., aged twenty-six. Admitted, June 18, 1926. Duration of illness before admission—forty-eight hours. Blood chemistry, not taken. Glycosuria, negative. Fat necrosis—positive. Leucocyte count, not taken. Stones in gall-bladder. Died.

Case VII.—(No. 55,487.) Mrs. E. A., aged forty. Admitted, October 10, 1927. Duration of illness before admission—thirty-six hours. Blood chemistry—98 milligrams sugar. Glycosuria, negative. Fat necrosis—negative. Leucocyte count—10,850. Stones in gall-bladder. Cured.

CASE VIII.—(No. 49,780.) Mrs. K. M., aged forty-four. Admitted, September 1, 1926. Duration of illness before admission—twenty-four hours. Blood chemistry—chlorides 250 milligrams CO_2 65. N. P. N. 38. Glycosuria, negative. Fat necrosis—positive. Leucocyte count, not taken. Stones in gall-bladder. Died.

CASE IX.—(No. 64,086.) E. B., aged twenty-four. Admitted, July 30, 1929. Duration of illness before admission—twenty-four hours. Blood chemistry, not taken. Glycosuria, negative. Fat necrosis—negative. Leucocyte count—16,700. Gall-bladder disease, positive. Cured.

CASE X.—(No. 66,431.) W. M., aged twenty-one. Admitted, January 1, 1930. Duration of illness before admission—forty-eight hours. Blood chemistry—four days after operation N. P. N. 32; sugar, ninety-nine; chlorides, 290. Glycosuria, negative. Fat necrosis—positive. Leucocyte count—19,000. Gall-bladder disease, negative. Died.

CASE XI.—(No. 65,743.) C. W., aged twenty-eight. Admitted, November 27, 1929. Duration of illness before admission, not given. Blood chemistry—N. P. N. 32 milligrams; sugar, 74 milligrams; chlorides, 250 milligrams. Glycosuria, negative. Fat necrosis—negative. Leucocyte count—18,200. Gall-bladder disease, positive. Cured.

CASE XII.—(No. 70,174.) C. W., aged forty-one. Admitted, September 26, 1930. Duration of illness before admission—five days. Blood chemistry, not taken. Glycosuria, negative. Fat necrosis—positive. Leucocyte count, not taken. Gall-bladder disease, negative. Cured.

CASE XIII.—(No. 70,092.) Mrs. C. M., aged fifty-seven. Admitted, September 21, 1930. Duration of illness before admission—twenty-four hours. Blood chemistry, not taken. Glycosuria, negative. Fat necrosis—positive. Leucocyte count—25,200. Gall-bladder disease, negative. Cured.

The etiology of acute pancreatitis is unknown. Schmieden[1] found associated gall-bladder disease present in 69.8 per cent. of 1,278 collected cases. In our group there were eight cases having associated gall-bladder disease. Deaver,[2] Maugeret,[3] Arnsperger,[4] and others believe there is a bacterial invasion into the pancreas, from the gall-bladder, by the way of the lymphatic system. Cultures taken in three of our cases, two of which had associated gall-bladder disease, showed a negative culture in each case. Two of the cultured cases had fat necrosis. This evidence does not support the bacterial theory. Cultures were taken from the peritoneal fluid.

Many investigators have produced acute pancreatitis by injecting bile into the pancreatic ducts. Wolfer[5] gives a rather complete bibliography of the work that has been done to produce acute pancreatitis experimentally. Opie, E. L.[6] and Guleke[7] believe there is a primary necrosis in acute pancreatitis which is followed by secondary hæmorrhage and suppuration.

Clinical pictures show a variation in the character of the onset, severity and duration of symptoms, but the pathological findings are not always in proportion to the severity and duration of the symptoms. Three cases (Nos. V, VII and IX) of our group, had an onset of violent symptoms, lasting from twenty-four to forty-eight hours, and, at operation, there was no hæmorrhage, liquefaction or necrosis. The pancreas in each case was swollen, firm and œdematous. Other cases (Nos. II, VI and XII) showed moderate severity of symptoms lasting forty-eight hours to five days, and, at operation, hæmorrhage, liquefaction and necrosis were found.

Symptomatology.—The predominating symptom in acute pancreatitis is pain. Usually the pain is a violent, "seizing pain," sudden in onset, and may be followed by rapid respirations, rapid feeble pulse, cyanosis and some times collapse. The pain is confined to the upper abdomen and in some cases to the left of the mid-line along the costal margin. Frequently the pain is not relieved by morphine. Halsted,[8] Bailey[9] and Turner[10] have described a peculiar type of cyanosis. Halsted described the cyanosis of the face and skin as a slate-blue color. Tenderness is found chiefly in the upper abdomen above the umbilicus or along the left costal margin. The abdomen may be soft and show distention rather than rigidity. Some authors describe a sensation on palpation of the upper abdomen as a "doughy mass." Nausea and vomiting are frequent initial symptoms.

Diagnosis.—In the diagnosis of acute pancreatitis the following conditions have to be differentiated: (1) Coronary thrombosis; (2) perforated ulcer, gastric and duodenal; (3) gall-stone colic; (4) kidney colic; (5) intestinal obstruction; (6) mesenteric thrombosis; (7) gastric crises; (8) ruptured ectopic pregnancy; (9) appendicitis; (10) twisted pedicle ovarian cyst, and (11) pneumoperitoneum.

Acute pancreatitis may be difficult to differentiate from certain cases of angina, especially the types of angina abdominis. A history of previous attacks of angina may be obtained. Tenderness and distention are not apt to occur in the cases of angina. In perforated ulcer there may have been a previous history of ulcer, either of gastric or duodenal type. Vomiting is *seldom seen* in cases of perforated ulcer. Vomiting is often seen in acute pancreatitis. A slow pulse is frequently observed in perforation, if the case is seen early. The opposite is true in the pancreatitis case. Board-like abdominal rigidity is more apt to be found in perforated ulcer while distention is usually found in pancreatitis. The two conditions are often confused because both frequently follow the ingestion of a large meal.

Associated gall-bladder disease is seen in 70 to 90 per cent. of cases of acute pancreatitis. This complicates the differential diagnosis; however, gall-bladder symptoms are more or less confined to the upper right abdominal quadrant. It is more apt to be confused with the more severe type of biliary disease, such as empyema or bile-duct obstruction. In bile-duct obstruction or empyema, chills, sweats and fever are common. Septic features are uncommon in early acute pancreatitis.

Kidney stone or especially ureteral calculus may present acute abdominal symptoms simulating acute pancreatitis. History of previous attacks may be obtained. Chills, sweats, fever, hæmaturia and pyuria would help to differentiate the above from acute pancreatitis. In addition, the pain in kidney disease radiates as a rule to the groin or genitalia.

Perhaps acute pancreatitis is mistaken more frequently for acute intestinal obstruction than any other condition. In consideration of all the various causes of obstruction, the first point to rule out is the history or evidence of previous operation. Strangulation of a loop of intestine through internal

hernial openings, such as diaphragmatic, sciatic, paraduodenal, pudendal or obturator foramen may be difficult to rule out. An X-ray examination of the chest may reveal a suspected diaphragmatic hernia. A strangulated sciatic or pudendal hernia may be palpated by rectal or vaginal examination. Strangulated obturator hernia often presents pain along the inner side of the thigh, radiating to the knee-joint (Howship-Romberg sign). The pain in pancreatitis is more apt to be confined to the upper abdomen. The pain in obstruction is more paroxysmal and generalized. Tenderness is more marked in the case of acute pancreatitis.

The picture in mesenteric thrombosis may be very similar to that of acute pancreatitis. One may find evidence of cardiovascular disease which may be a predisposing cause of mesenteric thrombosis. In mesenteric thrombosis blood and mucus may be found in the stools.

Gastric or tabetic crises may present symptoms like those seen in acute pancreatitis, *i.e.*, vomiting, pallor, sweating, collapse, and sudden severe epigastric pain which is referred to the back. Osler states rare cases have died in collapse. It is, therefore, very important to know if there is a history of a syphilitic infection, and a history of bowel and bladder disturbances. The presence of Argyll-Robertson pupil, the loss of knee kicks and a positive spinal fluid would help to differentiate the two conditions.

Pain, nausea, vomiting and collapse are seen in ruptured ectopic pregnancy and this condition may be confused with acute pancreatitis. One of the most characteristic symptoms seen in ruptured ectopic pregnancy is exquisite tenderness in the lower abdomen. There is hardly any acute abdominal accident that presents so much tenderness. The history of absence of menstruation and the presence of bloody vaginal discharge for one or two months would help to make the differential diagnosis.

One of the most frequent causes of acute abdominal pain is acute appendicitis. The pain in this condition is not quite so severe. Original epigastric pain is apt to localize in the lower right quadrant. A very constant symptom of acute appendicitis is pain in McBurney's region produced by coughing. Tenderness is found in the lower right quadrant rather than in the epigastrium.

Ovarian cyst with a twisted pedicle is another acute condition followed by sudden, sharp, colicky pain, nausea, vomiting and perhaps collapse. It is very much like the picture of intestinal obstruction. Tenderness and pain are more apt to be confined to the lower abdomen. A mass may be palpated by vaginal examination.

Pneumoperitoneum is always secondary to some other pathology such as a perforated gastric duodenal or intestinal ulcer. It is possible that pneumoperitoneum may be secondary to a pneumomediastinum. Therefore, an examination or X-ray of the chest may help to eliminate a case of pneumoperitoneum. In this case the peritoneal cavity may be charged with gas under tremendous pressure which could not be mistaken for acute pancreatitis. Pneumoperitoneum secondary to perforation of an abdominal viscus would

be more confusing. The differential diagnosis would be the same as that given above in perforated ulcer.

The writer has purposely omitted one point in the differential diagnosis of acute pancreatitis over the other conditions discussed. In the cases reported, herewith, a leucocyte count had been made in eight cases with an average count of 20,022, the highest count in any two cases was 28,100 and 25,800 while the lowest count in any two cases was 10,850 and 16,650 per cubic millimetre. I believe this to be the most important point in the statistical study of the cases reported. Marked leucocytosis is not found in coronary thrombosis, early perforated ulcer, intestinal obstruction, mesenteric thrombosis, gastric crises, ectopic pregnancy, twisted pedunculated ovarian cyst or pneumoperitoneum. It may be found in acute infectious gall or bile-duct disease or acute appendicitis. It is also present, late in the perforation of an abdominal viscus. The leucocyte count in acute appendicitis, as a rule, is not quite so high.

Treatment.—Körte[12] (1898) believed that operation should be delayed until the development of the subacute stage. Later[13] (1911) he advocated early operation. Most men now agree that early operation should be done. The hyperacute cases may make an exception to this rule (Archibald[14]). These patients may be given hypertonic salt and glucose solution prior to operation while waiting for recovery from the primary shock. Lahey[11] gives fifty milligrams of glucose in 750 cubic centimetres of salt solution to restore a reduced glycogen balance.

Six of this group of cases were operated upon after they had been ill forty-eight hours before admission to the hospital. There were five deaths. Four cases were operated upon after a lapse of twenty-four hours from the onset of illness. One of this group died. Yet, one patient who had been ill five days before operation recovered.

There is still a difference of opinion about the procedure to be followed in draining the bile-duct apparatus. Some men believe in cholecystectomy which seems to be a rather radical procedure. The gall-bladder was drained in all of these cases. If the disease should be due to the entrance of bile into the pancreatic ducts it would appear that cholecystostomy with subsequent drainage of bile to the exterior is the logical operation on the bile-duct apparatus. Another point in discussion is the question of blunt dissection of the pancreas. The pancreas may be dissected very cautiously with the finger, where there are multiple abscesses, yet it must be kept in mind that considerable hæmorrhage or injury to larger ducts may be the result of this dissection. A dissection of this sort was done in Case XIII of this group without any subsequent complications. The duration of illness, prior to operation in this case, was twenty-four hours. Large necrotic areas had developed and much of the pancreatic tissue sloughed away.

In addition to drainage of the gall-bladder, the capsule of the pancreas was incised and drained in all of these cases. Cigarette drains were used around the capsule. One cigarette drain was also placed down to the epiploic

foramen. Zinc oxide or 2 per cent. hydrochloric-acid ointment may be applied around the incision if pancreatic ferments digest the wound.

BIBLIOGRAPHY

[1] Schmieden, V., and Sebening, W.: Chirurgie des pankreas. Arch. f. klin. Chir. Kongressbericht, vol. cxlviii, pp. 319–387.

[2] Deaver, J. B.: Acute Gangrenous Pancreatitis. Internat. Clin., vol. xxix, s. 3, pp. 208–210, 1914.

[3] Maugeret, R.: Cholecysto-Pancreatitie: essai de pathogenie. Thesis, Paris, 1908.

[4] Arnsperger, L.; Die Entestehung der Pankreatitis bei Gallensteinen. Munchen. Med. Wchnschr., vol. lviii, pp. 729–731, 1911.

[5] Wolfer, J. A.: Acute Pancreatitis. Internat. Surg. Digest (Pryor), vol. vii, No. 4, pp. 211–221, 1929.

[6] Opie, E. L.: Disease of the Pancreas, Its Cause and Nature. 2 ed., roy. 8, Philadelphia, 1910.

[7] Guleke, N.: Die Neuren Ergebnisse in der Lehre der Akuten und Chronischen Erkeonkungen des Pankreas, mit besonderer Berucksuchtigung der entzundlichen Veranderungen. Ergebn. d. Chir. u. Orthop., vol. iv, pp. 408–507, 1912.

[8] Halsted, W. S.: Retro-injection of Bile into the Pancreas, a Cause of Acute Hemorrhagic Pancreatitis. Johns Hopkins Hosp., vol. xii, pp. 179–182, Bull., 1901.

[9] Bailey, H.: The Clinical Aspect of Acute Pancreatitis. British Med. Jour., vol. i, pp. 367–369, 1927.

[10] Turner, G. G.: Local Discoloration of the Abdominal Wall a Sign of Acute Pancreatitis. British Jour. Surg., vol. vii, p. 394, 1919–1920.

[11] Lahey, F. H.: Discussion of Hunt's paper. New. Eng. Jour. Med., vol. cxcviii, p. 615, 1928.

[12] Körte, W.: Die Chirurgischen Kranpheriten und die Verletzungen des Pankreas. F. Enke. Stuttgart, p. 81, 1898.

[13] Körte, W.: Surgical Treatment of Acute Pancreatitis. Arch. f. klin. Chir., vol. xcvi, p. 557, 1911.

[14] Archibald, E. W.: Surgical Diseases of the Pancreas. Lewis Practice of Surgery, vol. vii, pp. 35–43, 1929.

STUDY OF THE BLOOD-PLATELETS AFTER REMOVAL OF A RUPTURED SPLEEN *

By Benjamin Rice Shore, M.D. and Katherine V. Kreidel, A.B.
of New York, N. Y.

Studies of the blood-platelets after splenectomy for the rupture of an otherwise normal spleen are sufficiently rare to warrant the report of the following case.

Case Report.—The patient, a boy eleven years of age, was injured about eight o'clock in the evening by an automobile, which struck him on the right side and knocked him to the pavement. He was not unconscious and was able to rise unassisted to his hands and knees. There was no nausea or vomiting. He was somewhat disoriented. He was brought direct to the Vanderbilt Clinic and was transferred to the Babies Hospital two hours later. By this time he had vomited and was showing signs of shock. Shortly after his admission to the hospital he was given an infusion of 300 cubic centimetres of 10 per cent. glucose which improved his condition temporarily. At midnight, four hours after his injury, he began to vomit blood and by this time showed all the classical signs of hæmorrhage.

Examination showed contusions about the face and definite evidences of a fracture through the right ramus of the mandible. The left hip and thigh were also bruised. The abdomen was soft and relaxed and no tenderness, spasm, or shifting dullness could be elicited. As he was obviously in shock from loss of blood and fluoroscopical examination of the chest had eliminated hæmorrhage into the pleural cavity, the diagnosis of a ruptured intra-abdominal viscus with secondary hæmorrhage was made. The only localizing symptom was the vomiting of blood, which is commonly seen in traumatic rupture of the spleen.

Operation.—He was transfused with 400 cubic centimetres of whole blood and immediately afterward the abdomen was opened under local anæsthesia through a left rectus incision. The peritoneal cavity was completely filled with fresh and partly changed blood which welled up into the wound as rapidly as the field was dried. Open ether anæsthesia was begun at this point. Exploration showed all of the tissues in the left side of the abdomen including the mesocolon to be suffused with extravasated blood. The spleen was identified and a large rent was felt across its convex surface. The splenic pedicle was grasped between the index and middle fingers of the left hand, a clamp was placed distal to this, the pedicle was divided and the spleen removed. The pedicle was ligated with a transfixion suture of plain catgut; several other bleeding vessels were ligated and the splenic bed was left dry. The abdomen was closed in layers without drainage. The patient made a satisfactory post-operative recovery, his temperature being normal on the fourth day after operation. He was discharged from the hospital on the seventeenth post-operative day.

Pathological Report.—Examination of the spleen showed a tear on the diaphragmatic surface five centimetres long which extended through the underlying parenchyma to the visceral surface of the organ. On the latter surface there was another tear four centimetres long which was continuous with the one just described. Microscopical examination showed normal splenic tissue.

* From the Babies Hospital, New York, N. Y.

Follow-Up.—The blood of this patient has been watched with considerable interest since the day of his operation. (Fig. 1.) The hæmoglobin, which was 60 per cent. at the time of operation, has gradually but steadily increased to between 80 and 90 per cent., and the red blood-cells have increased from 2,700,000 to 4,584,000 per cubic millimetre. There has been

Date	Hb	R.B.C.	Platelets	W.B.C.	P	L	M	E	Miscellaneous
5-27-31	60%	2,776,000	392,000	9,050	74	25			Myelocyte 1
5-28-31	68%	3,016,000	432,000	9,000	87	12			Myelocyte 1
5-30-31	60%	3,272,000	408,000	9,000	81	18		1	
6- 2-31	60%	3,424,000	632,000	10,950	81	17	1	1	
6- 4-31	65%	2,896,000	984,000	8,750	77	20		2	Myeloblast 1
6- 5-31	65%	3,446,000	1,328,000	11,900	80	10	6	1	Myeloblast and myelocyte 1
6- 6-31	68%	3,832,000	1,488,000	8,400	85	13	1	1	
6- 8-31	70%	3,880,000	1,640,000	13,650	79	18	2	1	
6- 9-31	70%	3,424,000	1,600,000	10,050	67	28	5		
6-11-31	70%	3,600,000	1,576,000	6,750	71	26	3		
6-13-31	78%	4,088,000	1,404,000	6,300	63	25	11	1	Normal clot retraction
6-24-31	80%	4,088,000	576,000	7,700	40	44	10	6	Reticulocytes 0.6%
7- 9-31	88%	4,128,000	728,000	7,900	40	49	11		
8- 5-31	90%	4,192,000	560,000	8,350	40	54	4	2	
9-17-31	80%	4,016,000	664,000						
10-22-31	90%	4,040,000	728,000	7,050	34	50	12	4	
1-13-32	80%	4,584,000	784,000	8,150	51	44	2	3	

FIG. 1.—Blood counts following splenectomy for traumatic rupture of a normal spleen.

no essential change in the total white count, which has been around 8,000. The differential count has shown a gradual but steady increase in the lymphocytes, the last count being 51 per cent. polymorphonuclear leucocytes, 2 per cent. monocytes, 3 per cent. eosinophiles, and 44 per cent. lymphocytes. The chief interest, however, lies in the careful study of the blood-platelets. The

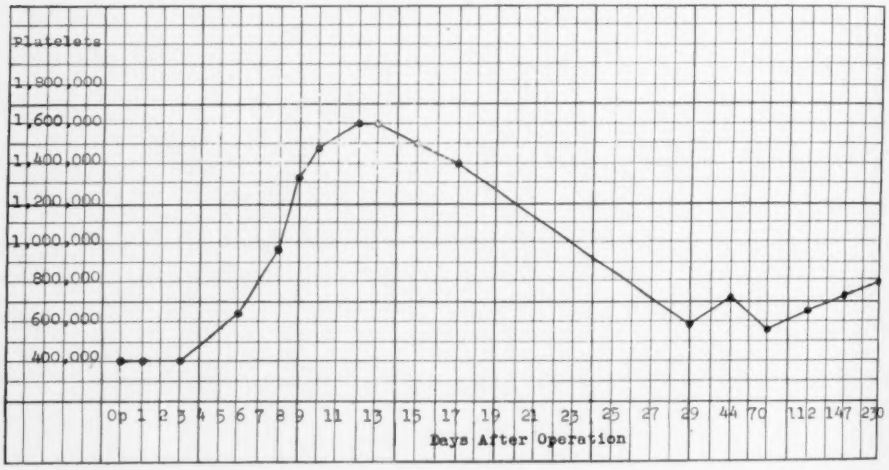


FIG. 2.—The curve of the platelet counts following the removal of a ruptured spleen.

first count done five hours after splenectomy showed 392,000 platelets per cubic millimetre. Daily counts showed the number of platelets to remain at this level until the sixth post-operative day, when they increased to 632,000. After that they rose rapidly to reach a peak of 1,640,000 on the twelfth day. This level was maintained for five days and then fell to its present level, which is around 700,000, seven and one-half months after operation. (Fig. 2.)

DISCUSSION.—The behavior of the blood-platelets after the removal of diseased spleens has become well known from the study of many cases. Careful studies of the platelets after splenectomy for rupture of a normal spleen are, however, rare. Such a case was reported by Evans,[1] in 1928, and is the only one which can be found in the recent literature. The first count done on Evans' patient showed 900,000 platelets on the tenth post-operative day. These rose to 1,100,000 on the thirteenth day and reached a maximum of 1,305,000 on the seventeenth day. They gradually fell, and the last count, which was done on the forty-first day after splenectomy, showed 650,000 platelets. The patient unfortunately died of intestinal obstruction on the sixty-fourth day, making a prolonged follow-up impossible.

The reaction of the platelets in this patient of Evans' and the one reported here after splenectomy for traumatic rupture is strikingly similar to that observed by Dawbarn, Earlam, and Evans[2] after other surgical procedures exclusive of splenectomy. These observers studied fifty unselected surgical cases and found a marked rise of the platelets which was manifested about the sixth post-operative day. This reached a maximum in about ten days which represented on the average an increase of 150 per cent. of the original count. This high level was maintained for a further few days and then the counts gradually returned to normal. The composite curve of the platelet counts in these fifty unselected surgical cases is identical to the curve of the platelet counts of the case here reported.

Other series of cases confirm the observations of Dawbarn, Earlam, and Evans. Hueck[3] reported the same results in 100, and Normann[4] in sixty unselected surgical cases exclusive of splenectomies. Included in this latter study were operations on the gall-bladder, stomach, perineum, bones, thorax, and kidneys. In these there was a marked post-operative increase of platelets which reached a maximum on the tenth to fourteenth day. This effect could not be ascribed to the anæsthetic as the same results were observed with the use of local anæsthesia. Since a similar rise was found in three traumatic cases without operation, the conclusion was drawn that the platelet rise was probably dependent upon absorption of toxic products from injured tissues and entirely independent of the type of the operation.

Experimental removal of normal spleens in animals has given platelet reactions which are identical with that seen in this case of splenectomy for rupture of a normal spleen. Steiner and Gunn[5] found that the removal of the spleen in rabbits was followed constantly by an increase in the number of circulating blood platelets. They also observed that other operations involving a similar degree of trauma were followed by an increase of platelets which did not differ in time of occurrence, degree or duration from that observed after splenectomy. The degree of the rise apparently depended upon the amount of trauma sustained by the tissues. Krumbhaar,[6] working with dogs, found an immediate rise in the blood-platelets after splenectomy but it is not stated if this is in terms of hours or days.

In this connection it must be remembered that while the type of platelet

reaction after splenectomy for thrombocytopenic purpura is the same as described for traumatic rupture of a normal spleen, the time of its onset is entirely different. Starting with a count below normal, an increase of the blood-platelets is observed in favorable cases as soon as one hour after splenectomy. This increase is rapid and reaches a peak far above the normal level in from six to ten days. To illustrate this one patient with thrombocytopenic purpura had a platelet count of 20,000 before operation which increased to 100,000 one and one-half hours after splenectomy. Daily counts demonstrated a rise to the maximum of 1,000,000, which was reached on the seventh post-operative day. It is evident, therefore, that splenectomy for thrombocytopenic purpura produces a platelet crisis which differs in its time of occurrence from that seen after other surgical operations and after the removal of a ruptured spleen.

Summary.—Studies of the blood-platelets following splenectomy for the traumatic rupture of an otherwise normal spleen showed a post-operative increase beginning on the sixth and reaching a maximum of 1,640,000 on the twelfth post-operative day. In its time of onset and degree this platelet crisis was similar to that seen after other surgical operations exclusive of splenectomy. The onset six days after operation was, however, entirely different from the immediate rise observed after splenectomy in favorable cases of thrombocytopenic purpura. A platelet count of over 700,000 has been maintained by this patient for the seven and one-half months during which his case has been followed.

BIBLIOGRAPHY

[1] Evans, W. H.: The Blood Changes After Splenectomy in Splenic Anæmia, Purpura Hemorrhagica and Acholuric Jaundice, with Special Reference to Platelets and Coagulation. Jour. Path. and Bact., vol. xxxi, p. 815, 1928.

[2] Dawbarn, R. Y., Earlam, F., and Evans, D. H.: The Relation of the Blood-platelets to Thrombosis after Operation and Parturition. Jour. Path. and Bact., vol. xxxi, p. 833, 1928.

[3] Hueck, H.: Changes in the Blood-platelets after Operations. Muench. med. Wchnschr., vol. lxxiii, p. 173, 1926.

[4] Normann, E.: What Is the Behavior of the Thrombocytes after Operations and What Is Their Relation to Post-operative Thrombosis? Deutsche Zeit. f. Chir., vol. ccxii, p. 166, 1928.

[5] Steiner, P. E., and Gunn, F. D.: Effect of Splenectomy and of Other Surgical Procedures Upon Circulating Blood-platelets. (Rabbits.) Proc. Soc. Exp. Biol. and Med., vol. xxviii, p. 1088, 1930–1931.

[6] Krumbhaar, E. B.: The Changes Produced in the Blood-picture by the Removal of the Normal Mammalian Spleen. Am. Jour. Med. Sci., vol. clxxxiv, p. 215, 1932.

CHRONIC DUODENAL ILEUS

By Ernst Kraas, M.D., and William C. Beck, M.D.

of Frankfurt, A/M., Germany

from the University Surgical Clinic in Frankfurt, A/M., Germany, Professor v. Schmieden, Director

Chronic duodenal ileus has been discussed in the literature under a variety of headings, such as chronic duodenal stasis, megaduodenum, chronic arterio-mesenteric occlusion, chronic intermittent duodenal ileus, *etc.* Therefore, only for a valid reason may one dare to add another term. The pathological process is indeed a complicated one, and it is our purpose to attempt a classification which will somewhat clarify the pathogenesis, and form a working basis for a therapeutic method. The title is chosen on the ground of the proposed classification.

History.—The first report appearing in the literature referring to duodenal ileus dates back to 1752, written in Latin by Boernerus. He related a case of almost complete constriction of the duodenum. In his article he refers to the previous work of Alsies and Sylvester on a similar subject. The next case appears reported by A. de Haen in 1763, in which the duodenum was compressed by the head of the pancreas, although he makes no mention of the nature of the pancreatic disease. Yeats (1820) wrote that obstruction of the duodenum may take place by compression of the transverse colon. He discussed the symptomatology, and included a description of the toxic manifestations. In 1829, the first case of congenital stenosis was reported by Guyot. The first case of obstruction by carcinoma complicated by perforation was described by Fullet, in 1833.

Obstruction of the duodenum by carcinoma of the head of the pancreas was reported by Mondinière in 1836, Holscher in 1840, Tanner in 1842, and again by Tiesser in 1847. In 1848 Anderson described a stricture of the duodenum. The following year Rokitanski suggested the relation of acute dilatation of the stomach to compression of the duodenum by the root of the mesentery.

Inler and Humby, in 1853, give an account of the relation of acute gastric dilatation to duodenal obstruction, and in 1852 Fagge described a case of acute gastric dilatation, with the post-mortem findings of duodenal obstruction and perforation. Bamberger (1855) reviewed the same subject. During the same year Heschl considered the compression of the duodenum by the root of the mesentery. The condition was again discussed by Brinton, in 1859. In 1886, Cahn wrote an article on the compression of the descending part of the duodenum by a sarcoma in the retroperitoneal lymph-nodes. During the same year the first case of duodenal obstruction by a gall-stone at the mouth of the common duct was mentioned by Riedel. Glénard (1889) suggested that traction from the dilated stomach causes narrowing of the duodenal-jejunal junction, and remarked that the condition was not one of tremendous rarity.

In 1890, Reiche reported a case of infrapapillary duodenal obstruction, just admitting the little finger, with periduodenal peritoneal adhesions as the etiological factor. The discussion was carried on by Kundrat, in 1891, who reported three cases of mesenteric obstruction, and in 1895 by Schnitzler. During the years 1852 to 1890, eighteen cases were collected of duodenal obstruction by pancreatic disease and duodenal carcinoma.*

In 1897, Dwight made wax casts of the duodenum demonstrating the U, V and S shapes, as well as the depression caused by the passage of the mesenteric vessels over

* For a reference to the cases see Anders, Am. Jour. Med. Sci., pp. 144, 360, 1912.

the organ. Two years later Albrecht reported two cases, and observed that if one placed a cadaver in a dorsal position and inserted the finger into the duodenum by traction on the mesentery in a downward and backward direction, a compression of the same could be demonstrated. He stated that such traction occurs clinically if the small intestine occupies the pelvis.

In 1900, Robinson reported the clinical and autopsy findings in duodenal obstruction, and in the same year Petit cured a case by suturing the jejunum to the transverse mesocolon. The first large series of cases was published by Thomson in 1902, whose monograph embraced an experience with some forty-four cases. Three years later Neck reviewed forty cases, which he compiled, and in 1908 Laffer reviewed the literature on the subject up to that time in a comprehensive article and included the compiled reports of 217 cases.

Since the beginning of the century a great deal has been written on the subject. The important contributions will be referred to in the following pages.

Etiology.—The cause of the dilatation of the duodenum certainly is not explained by one single abnormal process. The duodenum may assume a dilated state as a result of various factors which act either separately or in combination. According to all authors (Holmes), the dilated state is not a necessary companion of duodenal ileus. It is, however, almost always present, and, if present, is an invariable indication of duodenal stasis. Because of its development and anatomical relations it is particularly liable to produce a chronic obstruction.

The American and English authors are inclined to ascribe the dilated duodenum to demonstrable mechanical causes. Melchior, Duval, Schmieden and Kraas, as well as other continental authors, describe cases, however, where no such causes are traceable, and reserve for these processes the name "true megaduodenum."

To understand the "true megaduodenum" one must refer to the embryological development of the duodenum. The stomach and the proximal part of the small bowel develop during the latter half of the third embryonal week, as a thickening of the enteric tube, just below the incipient bud (Anlage) of the lung. Tandler has shown that between thirty and sixty days there occurs an overgrowth of epithelium so that the duodenal lumen is more or less completely obliterated.

This process is followed by a vacuolization of the epithelial mass. The vacuoles enlarge and the walls between them break down so that a continuous lumen is formed. An analogy is observed in the embryological development of the œsophagus. Tandler believed that if the vacuolization process was retarded, duodenal stenosis or even atresia might result. Forssner, Kreuter, Anders and Broman agree with Tandler in his anatomical findings and conclusions. To the inquiry of Lubarsch, why duodenal stenoses are then not more frequent in comparison with other intestinal stenosis, Tandler answered that when a comparison to the length of the organs is made, duodenal stenoses are fifteen times as common as stenosis in other parts of the intestinal tract.

Schmieden and Kraas suggest that if one accepts the congenital nature of the true megaduodenum, one might think of the possibility that this might be an overvacuolization. They, however, concede that the only embryological evidence to support such a theory is proposed by Noel. He found a coincident mesenterium commune in three cases. The presence of a true megaduodenum is supported by the findings of Melchior, Haberer, Duval, Mark and others of a dilated duodenum without and evidences of stenosis or constriction, even cases where the dilatation beyond the duodeno-jejunal junction extended for a considerable distance down the jejunum. Duval believed that these cases belong

to the idiopathic, congenital, segmental, intestinal dilatations. This contention is confirmed by a case from our clinic, where the dilatation of the duodenum was associated with a marked, well-defined dilatation, about eight centimetres in length, of the left half of the transverse colon.

Congenital atresia and congenital stenosis, which may be explained by Tandler's hypothesis, are reported in the clinical literature. Little and Helmholtz, in 1905, collected twenty-seven cases while Cordes collected some forty-eight cases of atresia and nine of stenosis.

The organ undergoes other changes in its developmental anatomy which render it liable to variations, these in turn being possible of producing extrinsic stenosis. Up to the fourth month of fetal life, the duodenum possesses a mesentery and swings freely in the abdominal cavity. At this time the duodenal mesentery becomes shorter and shorter and the organ is drawn against the posterior abdominal wall, there to lie retroperitoneally. Simultaneously, the right half of the colon is drawn posteriorly, crossing the descending ramus of the duodenum, and uniting with the transverse mesocolon. Here exists an opportunity for the occurrence of anomalies.

The duodenum may retain its mesentery (duodenum mobile) and swing freely in the peritoneal cavity. Such a case is reported by Freeman, wherein a kink was produced at the duodeno-jejunal junction which was fixed at the ligament of Treitz.

When the duodenum has reached its adult retroperitoneal position, it has assumed one of the several forms first described by Dwight. Its relations are of extreme importance in a further discussion of the different means by which it may become obstructed, and therefore it may be of value to review these.

In the concavity of the duodenal curve the pancreas is molded. The descending ramus lies upon the hilus of the right kidney, and, usually, is also in a certain relation to the corresponding suprarenal gland. Medialward is the course of the inferior vena cava. In the fold between the duodenum and the pancreas lies the common bile-duct. The anterior surface of the descending ramus is covered by the transverse colon and the gall-bladder.

The transverse or inferior part of the duodenum lies upon the inferior vena cava and the abdominal aorta, to which it is fixed by loose areolar tissue. Above it lies the pancreas, and anteriorly it is crossed by the mesenterial vessels, the artery to the left of the vein. The rest of it is covered anteriorly by the free loops of small intestine. The relation of the ascending ramus are of lesser importance, in case one should care to consider this as a separate division. Thus we see that the inferior or transverse ramus of the duodenum lies in an angle produced by branching of the mesenterial vessels from the large abdominal ones. Variations of the shape of the duodenum as described by Dwight and Merkel cause only minor variations in the anatomical relations.

Since the duodenum lies in such close proximity to organs which may be anomalous it is not surprising that compression may occur. The annular pancreas represents one such anomaly. It is comprehensively described by Guleke. The mesenterial vessels produce a definite constriction in the duodenum, as may be shown by formalin hardening of the duodenum (Merkel).

Valls studied the relation of the duodenum to the right colic arteries. He demonstrated that there are three freely anastomosing right colic arteries, which arise from a concavity in the superior mesenteric, pass between the layers of mesentery, and are bound to the posterior abdominal wall with the mesocolon. In 50 per cent. of the cases which he studied the right inferior colic artery passed below the duodenum, while in forty-three, five per cent. crossed the third portion obliquely, thus being capable of compressing it and producing a chronic obstruction.

Harris has, on the basis of operative findings, reported chronic duodenal obstruction caused by pressure from the hepatoduodenal ligament. All of his six cases had had feeding difficulties during infancy, and he reports complete cure following division of

this ligament. Niles has reported thirty-nine cases of a similar nature, all apparently with good results following analogous therapeutic measures.

Other congenital bands have been described and held responsible for deforming the duodenal passage. They are by some authors believed to be "crystallizations of the lines of force."

Because of the absence of a duodenal mesentery many of the causes of obstruction which are seen in other parts of the intestinal canal are rarely observed in this organ. Volvulus of the duodenum has been reported in the literature by Lebert, Rokitanski and Rembold, but it is of such rarity that it hardly deserves to be mentioned. Intussusception reported by Mayer, Sundlein and Wade, occupies a similar position.

Of greater importance are diseases affecting the neighboring organs which in turn produce duodenal compression. Several complications of cholelithiasis are capable of producing duodenal stenosis. Of first order are those where the gall-bladder filled with stones compresses the duodenum, a condition which has been termed by Melchior "duodenal gall-stones ileus." A second variety is observed, when precholecystic adhesions exert traction on the duodenum. Bryant, in an extensive study of visceral adhesions and bands, found the pericholecystic adhesions only second to those surrounding the colon. These, approximately equal in both sexes, were found to be present in direct proportion to the age of the patient. Such patients usually are considered as suffering from pyloric stenosis, although Tuffier and Marchais had already called attention to the fact that the adhesions run more commonly to the duodenum than to the stomach. These adhesions may distort almost any segment of the duodenum, even a low duodenal stenosis being reported by Hochhaus and Riedel. Apparently, according to Melchior, these adhesions are found only in cholecystitis accompanied by stones. Rather peculiarly, the simple removal of the stones will often relieve all of the signs and symptoms of the duodenal ileus, even though the strands are left, demonstrated by the cases of Severin and others.

Diseases of the pancreas may result in a duodenal stenosis. Of the anomalies annular pancreas has been mentioned. Most common of the acquired diseases are the neoplasmata. Carcinoma is the only one of importance, although an adenoma has been reported by Neve, and a cyst by Roux. Such obstructions usually occur in the lower portion of the organ. Inflammatory swellings of the pancreas may also result in stenosis, such as chronic pancreatitis, hæmorrhagic pancreatitis, and necrosing pancreatitis. A case of tuberculosis of the pancreas has been reported by Choostet, which produced a duodenal stenosis.

Enlargement of the retroduodenal lymph-glands through tumor metastasis or inflammatory disease may also produce compression. Similar in action to these is the compression of the duodenum by an aneurism of the abdominal aorta reported by Combessis, and Lebert. Perry and Shaw have reported constriction caused by a traumatic hæmatoma, as well as one of compression by a carcinoma of the gall-bladder. Stenosis by a tumor of the omentum has been reported by Augagneur, while Frereichs has mentioned constriction by an ecchinococcus cyst of the liver.

Constriction of the duodenum may be from pressure anteriorly by the mesenteric vessels, which brings us to a consideration of the large chapter of the so-called arteriomesenteric occlusions. A great deal of work has been done on this subject, but even today all of the attributed manifestations have not been made clear. Two forms of this syndrome exist, an acute and a chronic. Rokitanski first called attention to the acute gastro-mesenteric ileus as the cause of the acutely dilated stomach. There has been much work done since, both clinical and experimental, adding to the knowledge and clarifying the pathogenesis. An evaluation of these discussions is beyond the range and scope of this paper and will not be attempted.

We shall limit ourselves to a consideration of the chronic type of arteriomesenteric duodenal ileus. Glenard, in 1885, considered the chronic ileus as physiological. He believed that the physiological purpose was to allow time for the bile and the pancreatic secretion to mix with the gastric chyme. This contention has since been proven

false. Codman is of the opinion that chronic arteriomesenteric ileus is one of the effects of the change of the manner of living of the human species, the change from the quadruped to the biped position. To prove this contention he reproduces a sketch of a horizontal animal, the mesentery hanging vertically at right angles to the vertebral column and leaving the duodenum free. Then he draws a diagram of a corseted woman, which shows the mesentery again hanging vertically, but in this case compressing the duodenum against the vertebral column, with which it is now parallel.

As has been described above, the duodenum lies in the angle formed by the mesenteric vessels and the abdominal aorta.

It is most logical to surmise that traction on the mesenterial vessels in a downward and dorsal direction will increase the acute angularity of the angle, and therefore produce a compression beyond normal limits. Such traction can be produced if the cæcum and ascending colon swing freely on a mesentery. They are then capable of a prolapse and thus produce the required traction on the mesenteric vessels. Waugh found in several hundred autopsies on children a primitive mesentery on the ascending colon in 20 per cent. of all examinations. Kantor, in reporting eighty-five cases of duodenal ileus, states that 35 per cent. of these had an associated low cæcum. Bloodgood agrees with such a causation, and has resected the ptotic right colon in such patients.

Crouse presented the possibility of the mesentery of the small bowel being too short. This prevents the intestines from lying on the bony support of the pelvis and therefore pulls on the mesenteric attachment. The work of Albrecht previously referred to shows that in the autopsies on ten enteroptotic cases, "The pressure of the radix mesenterii on the horizontal portion of the duodenum was definitely greater than the normal physiologic limits." v. Haberer has pointed out the possibility of small bowel in hernial sacs being pulled downward by adhesions, thus causing traction on the mesenteric root.

Other conditions are capable of exerting traction on the mesenteric vessels. Codman has made the interesting statement that there is less pressure on the duodenum in fat people than in the thin ones, inasmuch as the mesenteric fat tends to distribute the pressure, while in thin people the duodenum is pressed directly against the spine.

A dilated cæcum, iliac stasis, lax abdominal walls, and visceroptosis all can cause mesenteric traction. The question arises, how much traction is needed to compress the duodenum? Dragstedt and Dragstedt have shown that a circular extrinsic pressure of six inches of water is sufficient to cause an acute duodenal obstruction with a fatal result. Much higher pressures are required to compress the jejunum, ileum or colon. Connor has found that traction on the mesentery by a weight of 500 grams will cause a complete occlusion. This is approximately the weight of the empty small intestine. Normally filled small intestine weighs about 2,000 grams.

Into the category of the arteriomesenteric duodenal ileus belongs a condition described by Lane and later on by Jordan, the duodenojejunal kink. Here the duodenum occupies a normal position and is not compressed, but the jejunum, instead of following its course to the left in its usual manner from the ligament of Treitz, either drops perpendicularly, or is even drawn to the right, thus producing a kink. Lane includes this with the ilial kink in a diagnosis of chronic intestinal stasis. Jordan mentions that this kinking can be demonstrated by the fluoroscope only with the patient in an upright position. The duodenum is always dilated, especially in its first and second parts.

We have discussed the developmental and extrinsic abnormalities which may cause dilatation, or stenosis and dilatation, and it remains to consider the intrinsic factors. The duodenum receives its sympathetic innervation from the celiac axis, while the parasympathetic system is found in the plexus of Meissner and Auerbach. According to the work of Frazer, instability in the nervous stimulus does occur, with the result that dilatations and spasms of the intestinal tube are produced. The exact nature and cause of these variations have not been clearly demonstrated. John Hunter has writ-

ten: "The tendency toward muscular hypertrophy as the result of repeated forcible contraction is particularly well marked in that of the involuntary type." A. J. Ochsner demonstrated in 1905 what he believed to be sphincter muscles in the duodenum, to whose spasm the chronic duodenal obstruction might be attributed. Two years later, Boothby demonstrated that the so-called Ochsner-muscle was dependent on local muscle spasm. Thomson believed that the hypertrophy has been produced because "from an early period it has been worried into overactivity by constant recurring overaction such as would result from habitual incoördination." Summing up, we may state these considerations from the neuromuscular theory of Devine, as one of the etiological factors of duodenal ileus.

Mention should be made of Jan Schoemaker's classing a certain group of chronic ileus cases in the same category as the red stomach. Here, he has shown, one has to deal with a neurogenical disease, although superficial examination would lead one to consider it to be an inflammatory reaction. He has demonstrated that there is only an intensive hyperæmia of the pyloric antrum, without any perivascular exudation.

FIG. 1.—Megaduodenum with a diverticulum on the posterior wall of the duodenum.

Still another disease of the duodenum may result in stenosis. One of us (Kraas) has pointed out elsewhere that in several cases from this clinic duodenal dilatation has been coincident with diverticula of that organ. (Fig. 1.) It is probable that in this instance there is a double developmental anomaly, rather than that the dilatation is secondary to the diverticulum. Duodenal neoplasmata do occur and have many times been reported as producing chronic obstruction. Duodenitis has also been considered as a cause of stenosis, partly because of the development of periduodenal adhesions which distort the organ against the abdominal aorta and the vertebral column.

Mathews, Delaney and Dragstedt have collected recently from the literature fifteen cases of hyperplastic tuberculosis of the duodenum which produced symptoms of stenosis.

Several authors have mentioned the possibility of chronic duodenal obstruction being the cause of some of the duodenal ulcers. Sloan cited fifty-two cases of duodenal ulcer in which there was a coincident narrowing of the duodenojejunal junction by adhesions. He considered the ulcer to be the secondary process. In view of the fact that so many ulcers are examined at the operating table and in the post-mortem room without the findings of a duodenal obstruction, would it not be more logical to suppose that adhesive strands which result in constriction are derived either from the ulcer directly or from the inflammatory process which either causes or accompanies the ulcers?

Classification.—The disease under discussion can be brought about by a heterogeneous variety of etiological factors, and, as the pathogenesis is one of the major indications in the method of therapy, we should like to suggest a classification on a basis similar to that by which intestinal obstruction is classified.

Two large groups may be identified:

(1) *The adynamic duodenal ileus.*—To this class belong all cases where no mechanical obstruction can be observed, *viz.*, the true megaduodenum of Duval, Melchior, Schmieden and Kraas, *etc.* The etiology still remains definitely to be cleared up, developmental and neuromuscular theories having been advanced, as well as placing it in a category with Hirschsprung's disease.

(2) *The dynamic chronic duodenal ileus.*—To this group belong all cases where a mechanical hindrance to the passage of the duodenum is discernible. As there are so many different possibilities of method of obstruction we further subdivide this group into

(*a*) *Intrinsic duodenal lesions.*—Here are classed the diseases affecting the

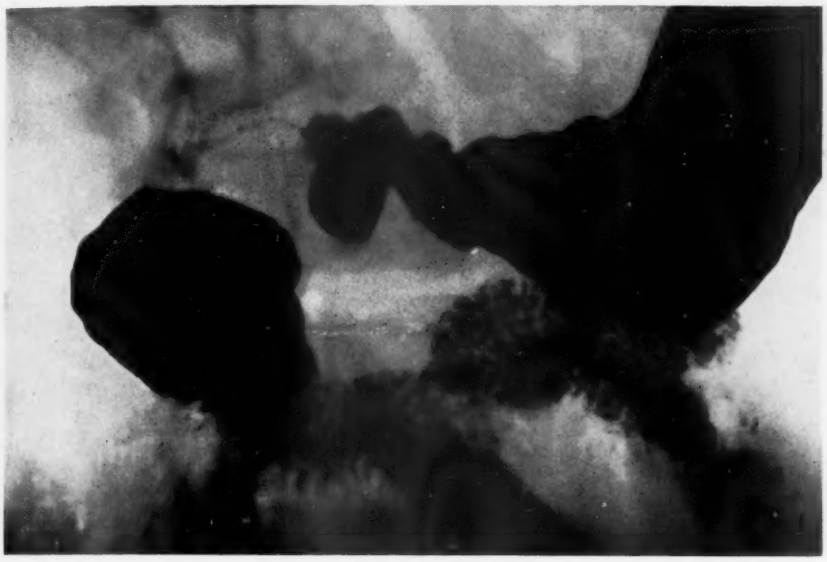


FIG. 2.—Megaduodenum with a diverticulum. There is an ulcer niche to be seen on the lesser curvature as well as on the duodenal bulb.

duodenum itself, such as neoplasm, duodenitis, congenital atresia, inflammatory disease (T.B.), duodenal-jejunal kink, diverticula, *etc.*

(*b*) *Extrinsic lesions.*—Under this heading we group the chronic arteriomesenteric occlusion (?), peritoneal strands and adhesions, and diseases of the surrounding organs which through pressure produce stenosis.

(*c*) *Complications of the duodenum mobile*, as hernias, intussusception, *etc.*

The part of the duodenum at which the stricture is produced in the cases of group 2 is, of course, of great importance, both from the standpoint of diagnosis and therapy, perhaps even more so than in obstruction of the small intestine. But in most cases this is determined by the anatomical relations of the etiological factor, and thus self-evident.

Frequency.—The frequency of occurrence is of considerable importance. In the American and in the English literature, chronic duodenal ileus has received a great deal of attention, rather in contradistinction to the continent.

The former contains several large series of cases. In clinics other than those reporting such series, one often finds that this diagnosis is of an extreme rarity. It may, and probably is, true that often the process is not looked for. The clinical history and physical examination, although suggestive to one who is alert for its occurrence, are far from being clear. The röntgenologist is often interested only in the duodenal bulb, and so overlooks pathological processes in the remainder of that organ.

Goldsmith has quoted Katkoczi as finding 0.6 per cent. such duodenal

FIG. 3.—Operative specimen showing an ulcer at the pylorus and one on the lesser curvature of the stomach and a dilated proximal portion of the duodenum. Insert shows the duodenal diverticulum removed in this case.

lesions in 4,500 autopsies in the two previous years. Kantor reported that up to 5 per cent. of 1,754 patients he examined had the röntgenological evidence of duodenal stasis with dilatation. Jewett, on the other hand, has found the diagnosis only in fifteen out of 30,000 admitted cases in a general hospital.

In general, the condition is somewhat more common in the female. Shattuck and Imboden found it to be so in a ratio of four to one. This may be due to the relaxation of the abdominal muscles following pregnancy. It may also be accounted for, in part, by the greater frequency of gall-bladder

disease in the female, although Bryant has found that there are more adhesions in the male. The patients are usually of middle age, in most cases of the asthenic type.

Symptoms.—For an adequate understanding of the symptoms we must have a conception of the physiology of this organ. Three fundamental physiological phenomena are at work, motility, secretion and absorption. Disturbance of one or more of these phenomena will cause definite changes in the organism. But, contrary to the general belief, and contrary to the reports which were given out from many physiological laboratories until recently, the duodenum is not a vital organ. Moorhead and Landes, as well as others more recently, have definitely shown that, with adequate surgical technic, the duodenum may be totally removed with impunity in animal experiments.

What the result is when experimentally a duodenal stenosis has been produced Morton and Sullivan have shown, demonstrating that the secretion in the duodenum undergoes a rapid increase, in contrast to an inertia of secretion in the jejunum and ileum under similar conditions. The duodenum dilates from the greater hydrostatic pressure. Some authors claim that the dilatation is the result of chemical activity, rather than the accumulation of secretion. Berg and Jobling have shown that not only is there a great dilatation of the organ, but also a marked hypertrophy and hyperplasia of the muscularis. They found free hydrochloric acid constantly in the stomach.

Normally, when free hydrochloric acid exists in the stomach the duodenal flora is not abundant. In achylia gastrica the flora is changed and much increased. Berg and Jobling state that in chronic duodenal ileus, although there still is acid in the stomach, the number of aerobic and anaerobes in the duodenum increases markedly, however, without much inflammatory reaction in the walls. The predominating organism is not always the same. The point just below the obstruction is much poorer in a flora than that immediately above. After a time, however, the bacteria are reduced in numbers, even though the obstruction remains. Ivy remarks that the flora in the obstructed segment closely resembles that of the ileum and that toxin-producing bacteria are present.

The animals in which the obstruction has been produced, according to Berg and Jobling, exhibit a moderate secondary anæmia, but no chemical changes in the blood. Their dogs also showed a chronic interstitial nephritis. This is of interest in connection with a report by Brown, Eustermann, Hartmann and Rowntree concerning the appearance of toxic nephritis in duodenal obstruction. They believe that without the duodenal mucosa no toxic substance would be developed in high intestinal obstruction. Dragstedt has demonstrated that in duodenal obstruction toxic substances may be absorbed, which under normal conditions does not occur. Brown and others have shown that there are changes in the renal function, the urine contains albumin and casts, and the blood is low in chlorides, high in urea and creatinin. Tisdall observed that the calcium-sodium ration is unchanged, so there must also be a reduction in the calcium, although we have found no direct reference to this.

FIG. 5.

FIG. 4.

FIG. 4.—Megaduodenum. The skiagram has been taken two hours after the ingestion of the contrast medium.

FIG. 5.—The same patient as in Fig. 4, the exposure being made ten hours after the ingestion of the contrast medium.

The symptoms of the disease entity are by no means accurate and definite, and the diagnosis is often a difficult one even after a careful röntgenological examination. Taylor observed that symptoms result when the obstruction is greater than peristaltic efficiency can easily overcome. The balance may gradually be lost with a slowly increasing symptom or be suddenly upset as a result of a prostrating injury or illness, when the viscus, becoming atonic, is no longer able to compensate the difficulty.

In many cases, according to Kellogg, symptoms appear only when the colon is filled and is dragged downward by the contents. Thus some of the symptoms will be characterized by a certain periodicity.

Most authors differentiate two types of subjective symptoms, the mechanical and the toxic. The latter consist in mental lassitude, fatigue, and headache, most commonly of the unilateral migraine type. An explanation of these toxic manifestations has been offered above in discussing absorption from the duodenum, and the bacterial flora. They are by no means constant, and assume a variety of form and intensity.

The mechanical symptoms have been classified by Wheelon as static or those following overdistention of the organ, and kinetic or those which are experienced when the organ exhibits abnormal motility. This rather fine differentiation he made by observing the symptoms when the patients were behind the fluoroscopical screen. In order to observe the effects of distending the normal duodenum, Ivy and others have swallowed small balloons and observed the sensations. Nausea, they state, is of most frequent occurrence. Pain is next in frequency. If the balloon is in the third part, the pain is referred to the epigastrium just above the umbilicus. As the balloon is withdrawn, the pain is felt on the right side just below the liver. Other symptoms which they noted were uneasiness, fainting, dragging and swaying sensations, dizziness, chilliness, and pallor. In some individuals a frontal headache set in.

Wheelon has characterized the sensations of fullness and localized heaviness as being the static type. Nausea, vomiting, pain, swaying and dragging sensations belong to the kinetic variety, with which Alvarez and Keeton agree.

Wolfer, on the other hand, is of the opinion that pain is due to pylorospasm. He states that in duodenal stasis the pyloric sphincter is tonic and prevents the regurgitation of duodenal contents into the stomach, which causes the pain or distress.

Duval describes attacks of migraine which coincide with the abdominal distress, and terminate with bilicus vomiting and diarrhœa. Kellogg states that the vomiting of large quantities of bile may be the chief complaint when the obstruction is below the level of the ampulla. If the pylorus does not yield diarrhœa may take the place of the vomiting. Barker laid great stress on the examination of the vomitus, claiming that the presence of bile or pancreatic secretion was evidence that the regurgitation was from the duodenum, but Melchior has proven that biliary vomiting is not always seen in duodenal obstruction.

The symptom which is common to many of the patients is that they have immediate relief on vomiting, also that they often get relief by lying on their right side in the knee-chest position. The discomfort is sometimes relieved by pressure over the lower abdomen. Kellogg cites cases where the patients lie face downward with their fists pressed deeply into the abdomen. The patients may also complain of a transient jaundice or temporarily acholic stools. Burget and Graham have shown that the tonus and motility of the duodenum play fundamental rôles in the passage of bile from the biliary passages. Higgins believes that this may be due to direct pressure from the dilated duodenum.

FIG. 5.—The same patient as in Fig. 4, the capsule being

The most characteristic elements in the symptomatology are the periodicity of the attacks, the fact that any food can bring them on, the association with headache, lassitude, *etc.*, and the manner in which relief is obtained, namely, assuming a bizarre position rather than by medication.

The physical findings are, unfortunately, minimal. The patient is often of the asthenic type with a lax abdominal wall, and a ptotic habitus. The upper abdomen may be distended, and the umbilicus may appear to lie higher than normal. According to Hayes, percussion will give a tympanitic sound behind the right rectus muscle and just to the right of the pylorus. The pleximeter finger must be placed with sufficient pressure to diminish gastric and colonic tympany, bringing the examining finger closer to the duodenum.

FIG. 6.

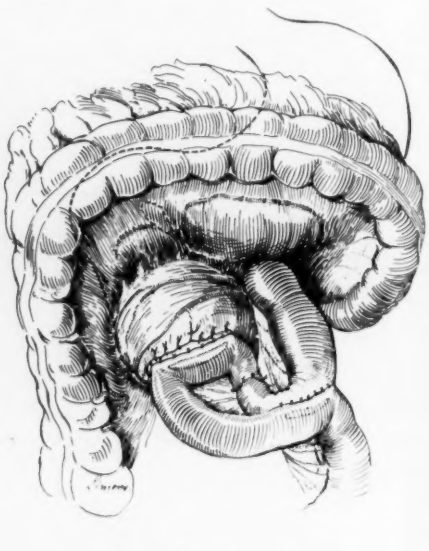


FIG. 7.

FIG. 6.—Sketch made during an operation. The hepatic flexure of the colon is held high, revealing the inferior duodenal flexure protruding through the transverse mesocolon. The proximal portion of the jejunum is also dilated. (Therefore a case of adynamic duodenal ileus.)

FIG. 7.—Sketch made during an operation, showing a typical inframesocolic duodeno-jejunostomy, combined with a Braun entero-enterostomy. The afferent jejunal loop has been closed. Same case as illustrated in Fig. 6.

Pressure upward and backward beneath the transverse colon permits the duodenum to empty. Gas can then be felt or heard rushing into the jejunum, after which the sound will be relatively dull. Case has described succusion over the duodenum. Zade suggested the use of a stomach tube comparing the amount of water put into the stomach with the amount he could recover.

The diagnosis may be suggested by the clinical history and physical examination, but a röntgenological study is always required. It is made with the fluoroscopical screen, both in the erect and in the supine position. To observe the lower third part of the duodenum the patient is best placed in a semilateral position with his right side nearest the screen, thus projecting the stomach away from the duodenum. The differentiation from duodenal diverticula may be difficult, and then may be coincidental. To rule these out

pressure should be applied over the area, the contrast medium being pushed out of the duodenum and remaining in the diverticulum. Follow-up examinations several hours later may also be of value in clearing up this point.

From the Röntgen viewpoint the symptoms differ with respect to the part of the duodenum at which the stenosis occurs. Stenosis of the first part of the duodenum is clinically tantamount to pyloric obstruction. Case states that it cannot be diagnosed by the radiologist. The case in which the clinical signs are those of a pyloric stenosis, and the radiologist sees a deformed duodenal bulb, may, however, according to most observers be considered as a stenosis of the first part.

When the obstruction comes between the first and the second parts, the junction between these parts appears to be very high, according to Bell, Keith and Keith. They state that the duodenal bulb is usually long and dilated and frequently there is delay in expulsion of material from it. The bulb is often deformed, and may, according to Harris, assume an S-shaped curve. The stomach is dilated, its antrum lying to the right of the mid-line. The distorted bulb, however, has a different appearance than that seen with duodenal ulcer. Taylor is of the opinion that the hyperactivity of the stomach, combined with hypertonicity, later gives way to dilatation and ptosis. His belief is that many of the ptosed and fish-hook types of stomachs are the result of duodenal ileus, as operative relief from obstruction is followed by a rapid improvement in its size and position. Brinkner and Milch have reported that on relief of duodenal obstruction, gastric motility increases.

Stenosis between the second and third parts has been reported by McConnell and Hardman. The röntgen findings are very similar to those in which the lesion is at the point where the mesenteric vessels cross the duodenum, and which will be discussed with the latter lesion. Kantor, however, makes the observation that if the second part is obstructed it will be pulled far to the right of its normal position.

In studying the obstruction of the inferior ramus, the size, the shape, the position, and the motility must be taken into consideration. As regards size there is some difference of opinion. Holmes and others are of the opinion that the organ does not necessarily appear dilated. We know that in most cases, however, a definite dilatation is present, and that experiments, such as those of Berg and Jobling, invariably show a similar result. The organ may assume huge proportions as may be seen in one of the accompanying illustrations.

The stomach in these cases is usually large and lying low. The duodenal bulb is wide and long. The contrast medium is then seen transversing and descending ramus and entering the third part. Here, according to Case, it is thrown back to the bulb by a powerful antiperistaltic action. "In the meantime, as a result of the gradual filling of the third portion, a peculiar shadow with convexity downward develops, which becomes larger and larger as the former movement is repeated." Soon rather violent waves of peristalsis will be seen and the barium will gather just orally to the point of obstruction. Then some of the barium will pass, and will be seen rapidly coursing through the remainder of the duodenum into the jejunum. Shattuck and Imboden have pointed out that the valvulæ connites are obliterated.

The reverse peristalsis in itself is not sufficient evidence for a diagnosis of duodenal ileus. Wheelon has observed reversed movements in people with a normal or even shortened gastric emptying time. Ivy states that they are due to reflexes from the cœliac ganglion as well as from enteric reflexes, the same as when strong acid chyme has been injected into the duodenum. Reversed movements take place in vomiting, and in certain gall-bladder diseases. Henderson has reported antiperistalsis in 93 per cent. of 102 patients infected with hookworms. Berg and Jobling have corroborated the work

of Wheelon and Thomas, and have found that the pyloric sphincter accommodates itself to the reversed peristalsis of the duodenum, relaxing during the negative antral phase and thus permitting regurgitation.

Obstruction at the ligament of Treitz, according to Bell, Keith and Keith, is exactly similar to the foregoing except for the point of stenosis, which is situated higher and more to the left; Shattuck and Imboden are of the opinion that this is the specific point of stenosis when one observes a writhing duodenum, and that the duodenojejunal angle is found to the right of the vertebræ. In the presence of the so-called Lane's gastrojejunal kink, the barium is to be seen swinging off to the right in a sharp angle to its former course.

The diagnosis on the Röntgen findings is difficult, as may be imagined when the report of Kellogg and Kellogg shows that in only twelve of the forty-one cases coming to the operating table had the diagnosis been made on radiological examination.

Diagnosis.—The diagnosis is by no means a simple one, as will be gathered from the above. A dilated duodenum is suspected in an asthenic individual, with lax abdominal musculature who complains of distress in the right hypochondrium. A careful history may bring out some of the characteristic symptoms alluded to, but the physical signs are the minimal value. Combining these with a complete röntgenological examination, including a study of the entire length of the duodenum, will in all probability make the diagnosis in a large number of cases, many of whom have been referred to the surgeon as obscure abdominal disease.

In the differential diagnosis gall-bladder disease and duodenal ulcer are most important. Acute appendicitis has been suspected in some. But it is more important that chronic duodenal ileus be placed in the differential diagnosis of the more common afflictions producing upper abdominal distress. It must be remembered that the chronic dynamic type is secondary to another pathological process, and so it may be a coincidental finding at operation and may be looked for. In Kellogg and Kellogg's series of forty-one cases the diagnosis was made in only twenty-three pre-operatively, but the alert surgeon looks for it and is rewarded.

Treatment.—Once the diagnosis has been established without question, one has at his disposal a conservative course, and an operative one.

The former is directed against ptosis, an attempt to relieve the stress on the mesenteric root. It is, therefore, of effect only in the cases of the arteriomesenteric dynamic type, and at best only in a palliative sense. Holmes has expressed the opinion that the medical treatment will "tax the skill and ingenuity of even the most accomplished physician." He recommends prolonged bed rest and over-alimentation in the visceroptotic group. Others have recommended rest in a moderate Trendelenburg position and the wearing of abdominal binders and supports, thus combating the laxity of the abdominal musculature. Massage of the abdominal wall and postural exercises may prove valuable. Very frequent small feedings of a high caloric diet are advantageous, with a rigid care of the colon offsetting constipation with mild laxatives. The cure, however, is rarely destined to be permanent and surgical treatment will necessarily demand consideration.

Schoemaker has warned that many of the patients, especially those where we find an associated red membrane, are of a functional type, which, instead of being improved, are definitely set back by operative interference. Carslaw quotes Wilkie as saying that he had decided to set the indication more stringently than he had up to that time, reserving the operation to those cases where there is definite fluoroscopical evidence of duodenal dilatation.

Operative intervention should not be attempted before the patient's general condition has carefully been checked. Wolfer calls attention to the possibility of the patient's tolerating a rather high grade of obstruction and remaining in good physical condition. Yet a sudden anatomical accident may cause an acute exacerbation characterized by a severe toxæmia. Other cases are extremely ill and will tolerate but little surgical trauma. For this type of patient repeated duodenal lavage with the Levine or Rehfuss tube is of distinct value. To combat the toxæmia, the method of Dragstedt may be employed, which consists in the intravenous infusion of 500 cubic centimetres of Ronger's solution every four hours for twenty-four hours. Blood-chemistry studies previously referred to indicate that there is often a deficiency in the blood chlorides and possibly in the calcium. Haden and Orr, with this in mind, recommend the infusion of sodium chloride.

Little of anything has been remarked in the literature about examination of the renal function. Further investigation, by the methods now commonly in use, might prove profitable in the pre-operative period, and perhaps might save the patient from renal embarrassment during the post-operative days. Should jaundice be an accompanying factor, or gall-bladder disease be coincidental, the intravenous administration of glucose and calcium may be advantageous, perhaps combined with insulin, to stave off a hyperglycæmic reaction.

The surgical indication should be set with great care.

The choice of the operation is in many cases a difficult one and should be governed by the etiology. W. J. Mayo has said:

> "If the small bands of adhesions found in one case can be productive of harm to one patient, how can we expect another with similar symptoms to be benefited by the bands of adhesions which the surgeon forms to hold up a prolapsed organ? How much truth, and how much fancy, is wrapped up in the elucidation of this problem no one can say. Another group contends that they are all neurasthenics. That many patients have been benefited by operation is beyond doubt, yet if one were to take the case histories and successful reports of treatment by such mechanical therapy, and put them all in a hat to be picked out at random, one could not determine from the histories of the patients those who had been relieved of symptoms by operating for a mobile cæcum, for mobility of the colon, for prolapse of the stomach, or even for movable kidney."

In this statement, paradoxically Doctor Mayo emphasized the most vital point in determining the operative procedure. The symptoms are caused by the chronic ileus, but the etiology of the obstruction is most complex and varied.

In many cases of the dynamic type it is possible, after recognition of the

etiological process, to correct it. With the tremendous variety of etiological processes, it is only natural that a wide variety of procedures has been recommended. The intrinsic lesions are usually treated by a nutrient jejunostomy or one of the short-circuiting operations. The latter will be discussed later.

In the extrinsic lesions the attack is to be directed against the cause, and, in selected cases, combined with a short-circuit operation. Gall-stones should be removed, bands of adhesions definitely producing a kink should be separated by sharp dissection. In diseases of the pancreas causing duodenal stenosis one of the short-circuiting operations must be resorted to. For obstruction in the first portion with gastroptosis, and with the superior angle normally placed, and free from pathology, except for kinking caused by the dragging of the stomach Beyea has recommended gastropexy. His enthusiastic reports were not corroborated by all workers, but there are also many reports of its application with good success. Kellogg and Kellogg say that it is particularly adapted when there is a roomy abdomen and a broad subcostal arch. Its advantages are that it is practically free from danger and is a simple procedure not likely to produce many adhesions.

The majority of operations in this group have been directed towards relief of the chronic arteriomesenteric type. Division of the duodenum, with an anastomosis between the cut ends anterior to the mesenteric root, has been suggested and, fortunately, promptly forgotten. Suture of the mesenteric root to the transverse mesocolon; Coffey's suturing of the omentum to the abdominal wall; taking a reef in the gastrocolic omentum, have been advised if the transverse colon is prolapsed.

When the ascending colon is held in a position of hyperfixation by the hepato-duodeno-colic band, Harris has advised that the band be divided and the hepatic flexure lowered. In the event of a cæcum mobile, with duodenal compression by the right colic artery, a right colpexy with plication of the cæcum is usually done. The latter procedure is designed to keep the cæcum from prolapsing into the pelvis. Bloodgood has reported a large series of cases in which he resected the right half of the colon and cæcum, combined with an ileocolostomy. Most authors, however, believe this operation too radical.

For the so-called duodenojejunal kink, several procedures have been advised. The ligament of Treitz may be stretched or divided, the latter procedure having been described by Freeman. The jejunum may be fixed to the transverse mesocolon, so that it sweeps off to the left.

The short-circuiting operations are used in the cases of the adynamic type, and in those cases where either the stenosis cannot be alleviated or only partly so. Gastroenterostomy of the posteromesocolic type has been done in many cases, with varying reports of success and failure. From a physiological standpoint, however, it is always most advantageous in a short-circuit procedure to have the anastomosis at the most dependent point of the dilated bowel. In the adynamic ileus and in the cases of obstruction at the mes-

enteric root, as well as at the gastrojejunal junction, the procedure of choice anatomically is the duodenojejunostomy.

This operation, suggested by Barker in 1906 and Bloodgood in 1907, and first performed by Stavely one year later, Bartlett, in 1913, reported duodenojejunostomy using a Murphy button to complete the anastomosis. Ernst did the first successful operation on a congenital stenosis of the duodenum in an eleven-day-old child. Large series have been reported by Wilkie (sixty-four cases) and Kellogg and Kellogg (ninety-two cases). The operation is facilitated by the fact that the duodenum is dilated, and, therefore, usually more easily accessible. The transverse colon being raised, and some pressure applied from above, will bring the duodenum well into view as a bulge in the mesocolon. An anastomosis between a high loop of the jejunum is now made in the direction from lower right to upper left, which has been shown by Kraas to be the best to include the most dependent part of the duodenum. Schmieden and Kraas also point out that, in order to obviate any possibility of stasis in the proximal jejunal loop, it is best to also perform an entero-enterostomy, after the method of Braun.

In the case described recently by Beck, there was stasis in the ascending duodenal loop necessitating a second operation, at which time the duodenum just distal to the duodenojejunostomy was cut across, and both ends closed. This procedure, however, is not altogether free from danger, and in all probability will not become a method of choice.

Should chronic duodenal stasis be coincidental with a duodenal or gastric ulcer one is confronted with a somewhat difficult problem, for if one performs a gastroenterostomy or a gastric resection, there will be an accumulation of the duodenal pancreatic and biliary secretion in the dilated duodenal segment as well as back flow from the proximal jejunal segment. Several authors have advised combining the procedure chosen for treatment of the ulcer with a duodenojejunostomy. A case treated at this clinic with a gastric resection by the Polya Billroth II technic necessitated a subsequent duodenojejunostomy. Kraas has suggested that in these cases the possibility of the backing up of chyme into the duodenum can be avoided by making use of the Y-anastomosis suggested by Roux, in a termino-lateral gastrojejunostomy after resection. This might obviate such cases as described by Bloodgood in 1912.

For obstruction in the first part the treatment should be approximately the same as that for pyloric stenosis; removal of the cause, if possible, or pyloroplasty, gastroenterostomy or gastrectomy. For the comparatively rare lesion in the second portion Kellogg has suggested the use of a duodenoduodenostomy.

The post-operative treatment should be carefully carried out. Wilkie has stressed the importance of postural therapy, *viz.*, the foot of the bed elevated. In the immediate post-operative period the usual routine for gastric surgery should be followed. Later it is advisable that the patient wear a supporting belt, and be given exercises, *etc.*, to strengthen the abdominal musculature.

Prognosis.—The prognosis depends on the etiology. As in most cases a definite operative procedure can correct a mechanical defect, or, in the cases of the adynamic type, it is possible to aid the emptying of the dilated organ,

one is led to believe the results of operative interference should be most gratifying. However, the reports in the literature are not all over-optimistic. Kellogg and Kellogg, in thirty cases of duodenojejunostomy, report eighteen as cured, nine as improved markedly, three unimproved. Carslaw quotes Wilkie's fifty-six followed cases, with twenty-three cured and eleven much improved.

The gist of the discussion is that the indication for the operative interference will have to be set with the greatest of care, and only after a careful consideration of the entiology of the specific case. The operations are not entirely free from danger. Schoemaker has warned that in a certain percentage of the patients functional elements play an important rôle, and these people will not be benefited by any operative measures.

SUMMARY AND CONCLUSIONS

(1) There are two types of chronic duodenal ileus, one in which a definite mechanical obstruction to the passage of food through the duodenum may be found, and another where it is lacking.

(2) It has been suggested that a classification be adopted according to the etiology, grouping the mechanical obstructions under the term dynamic ileus, and the functional obstructions as adynamic ileus. Under these two headings the individual causes are to be listed.

(3) The occurrence of such cases is probably greater than clinical experience would indicate, but because of the variety in appearance, the lack of physical signs, difficulty in röntgenological demonstrations, the diagnosis, it is often missed. Probably another factor is that it is not thought of or looked for, either in fluoroscopical examination of the stomach or at operation on the stomach or neighboring viscera.

BIBLIOGRAPHY

Adams: Duodenal Ileus. Brit. Jour. Surg., vol. xiv, p. 67, 1926.
Ancel, and Sencert: Morphologie du Peritoin. J. de l'Anat. et de la Physiol., vol. xxxix, p. 353, 1903.
Ancelet: Etudes sur Maladies de Pancreas. Paris, 1866.
Anders: Stenosis of Duodenum. Am. Jour. Med. Sci., vol. clxiv, p. 360, 1912.
Anderson: Stricture of Duodenum. New Orleans Med. and Surg. Jour., vol. v, p. 480, 1848.
Anderson: Annular Pancreas. Brit. Jour. Surg., vol. x, p. 316, 1922.
Bakay: Arch. Klin. Chir., p. 141.
Baldwin: Anat. Rec., vol. iv, p. 299, 1910.
Baumel: Duodenitis. Montpillier Med., vol. ii, p. 386, 1887.
Bell, Keith, and Keith: Duodenal Ileus. Radiology, vol. ix, p. 15, 1927.
Berg, and Jobling: Experimental Duodenal Ileus. Arch. Surg., vol. xvi, p. 593, 1928.
Idem: Ibid., vol. xiv, pp. 752 and 763, 1927.
Bloise, and Volpe: Arch. Pediatr., vol. i, 1930.
Bloodgood: Dilatation of Duodenum. ANNALS OF SURGERY, vol. xlvi, p. 736, 1907.
Idem: Jour. Am. Med. Assn., vol. lix, p. 117, 1912.
Idem: Internat. Surg. Digest, vol. i, p. 259, 1926.
Boernerus: De Tabe Sicca Lethale. Acta Acad. Nat. Curios., p. 225, 1752.
Boothby: Boston Med. and Surg. Jour., vol. clvii, p. 80, 1907.

Bricon: Progress Medical, vol. vii, p. 27, 1888.
Brin, et Denechan: Bull. Soc. Med. Hop., Paris, No. 41, 1925.
Brinkner, and Milch: Int. Klin., vol. ii, p. 241, 1926.
Broman: Entwickellungsgeschichte. Verlag Bergmann, 1921.
Brown, Eustermann, *et al.*: Arch. Int. Med., vol. xxxii, p. 435, 1923.
Bryant: Am. Jour. Med. Sci., vol. clxv, p. 111, 1923.
Burget: Am. Jour. Physiol., vol. lxxiv, p. 583, 1925.
Buy: Bibliogr. Anat., vol. xii, p. 65, 1903.
Cambell: Australian Med. Gazette, vol. xxxiv, p. 381, 1913.
Case: Chronic Obstruction of Duodenum. Radiology, vol. ix, p. 1, 1927.
Chiladati: Les Plises de Duod. Bull. et Mem. de la Soc. Radiol., vol. iii, p. 43, 1911.
Codman: Duodenal Obstruction. Boston Med. and Surg. Jour., vol. clviii, p. 503, 1908.
Coffey: Fixation of Abdominal Organs. Jour. Am. Med. Assn., vol. lxv, p. 1809, 1915.
Cole: Veils in the Hypochondrium. Am. Jour. Roentgenol., vol. ix, p. 137, 1922.
Connell, and Adams: Doublin Jour. of Abdom. Sci., ser. 4, 1921.
Crouse: Chronic Duodenal Dilatation. Arch. Surg., vol. i, p. 538, 1920.
Idem: Texas State Med., March, 1920.
Denzer: Am. Jour. Diseases of Child., No. 24, 1922.
Dragstedt, and Dragstedt: Jour. Am. Med. Assn., vol. lxxix, p. 612, 1922.
Duval, *et al.*: Etudes sur la Duod. Paris, 1924.
Idem: Archiv. d. mal. de l'app. digest., vol. xiii, p. 996, 1923.
Idem: Ibid., vol. xiv, pp. 74 and 197, 1924.
Idem: Arch. Ital. Chir., vol. xviii.
Eastmann: Jour. Am. Med. Assn., vol. lxi, p. 635, 1913.
Eckersdorf: Suprapapillare Duodenal Geschwuere. MmW, p. 2125, 1906.
Ehrmann: Archiv. für Ges. Phys., vol. cxix, p. 247, 1908.
Eichler: Berliner klin. Woch., p. 1172, 1908.
Eichmeyer: Archiv. klin. Chir., vol. cliii.
Eisendrath: ANNALS OF SURGERY, vol. lx, p. 62, 1914.
Fasiani: Archiv. Ital. Chir., vol. xviii.
Faucet, and Bachford: Duodenum and the Vert. Column. Jour. Anat. and Physiol., vol. xxxviii, p. 435, 1903.
Finney: Dilated Duodenum and the Stomach. Johns Hopkins Bull., p. 37, 1906.
Flint: *Ibid.*, vol. xxiii, p. 302, 1912.
Florand: Bull. Med., 1926.
Frank: Ileus of Duodenum. Niederl. Maandschr. v. Geneesk., vol. xvii, p. 495, 1931.
Freeman: Surg., Gynec., and Obst., vol. xxx, p. 434, 1920.
Friedenwald, and Feldmann: Am. Jour. Med. Sci., vol. clxxviii.
Gamherini: Bull. Sci. Med., vol. ix.
Gerster: ANNALS OF SURGERY, vol. lvi, p. 583, 1912.
Ghiron: Poliklinico sez Chirurg., vol. xxxii, 1925.
Glinski: Virchow's Archiv., p. 164, 1901.
Göttke: Med. Welt., 1931.
Graham: Proc. Chicago Inst. Med., vol. vi, p. 88, 1926.
Gray, and Andersen: Abdominal Adhesions. Lancet, vol. i, p. 1300, 1913.
Grégoir: Bull. Soc. Nat. Chir., vol. liii.
Guleke: Ergebnisse der Chir., vol. iv, p. 437.
Haberer: Archiv. für klin. Chir., vol. cxxxii.
Haden, and Orr: Exp. Duodenal Obstruction. J. Exp. Med., vol. xli, p. 707, 1925.
Halpert: Duodenal Obstruction. Johns Hopkins Bull., vol. xxxviii, p. 409, 1926.
Hammann: Faulty Intestinal Rotation. ANNALS OF SURGERY, vol. lxxvi, p. 41, 1922.
Harman: Variations of Duodeno-Jejunal Flext. Jour. Anat. and Physiol., p. 665, 1897-1898.
Harris: Mesogastric Folds. Jour. Am. Med. Assn., vol. lxii, p. 1211, 1914.
Harvey: Congenital Peritoneal Variations. ANNALS OF SURGERY, vol. lxvii, 1918.

Hayes, and Shaw: Intermittent Dodenal Stenosis. Radiology, vol. xiii, p. 245, 1929.
Hayes: Intestinal Stasis. N. Y. Med. Jour., January 24, 1914.
Helizka: Archiv. Italiennes de Biol., p. 22, 1908.
Henderson: Roentgen Aspect of Duodenal Dilatation. South Med. Jour., vol. xxii, 1929.
Heske, and Best: Congenital Duodenal Constr. Am. Jour. Dis. Child., vol. xxxvi, pp. 122-124, 1928.
Higgins, *et al.*: Congenital Duodenal Stenosis. *Ibid.*, vol. xxxvii, p. 826.
Idem: Chronic Duodenal Ileus. Arch. Surg., vol. xiii, 1926.
Hochaus: Quoted by Melchoir.
Hochstetter: Fortschr. der Roengenstr., vol. xxix.
Holmes: Chronic Obstruction of the Duodenum. Radiology, vol. ix, p. 43, 1927.
Homans: Duodenal Bands. Boston Med. and Surg. Jour., vol. clxxv, p. 665, 1916.
Ivy: Physiology of Duodenum. Radiology, vol. ix, p. 47, 1927.
Jackson: Surg., Gynec., and Obst., vol. x, p. 278, 1909.
Jewett: Chronic Duodenal Ileus. Jour. Am. Med. Assn., vol. xci, p. 91, 1928.
Jonnesco: Sur l'anatomie du Duodenum. Progres Med. de Paris, vol. ix, p. 176, 1899.
Judd: Pathology of Duodenum. Jour. Lancet, vol. xli, 1921.
Judd, and White: ANNALS OF SURGERY, vol. lxxxix.
Jutte: Autointoxication and Duodenal Lavage. Am. Jour. Med. Sci., vol. cliii, p. 172, 1917.
Kantor: Common Anomalies of Duodenum and Colon. Jour. Am. Med. Assn., vol. xcvii, p. 1785, 1931.
Kellogg, and Kellogg: Chronic Duodenal Stasis. ANNALS OF SURGERY, p. 578, 1921.
Idem: Surg., Gynec., and Obst., vol. xxviii, p. 174, 1919.
Idem: Radiology, vol. ix, p. 23, 1927.
Kerley: Enteroptosis in Children. N. Y. Med. Jour., October, 1921.
Kiek: On Duodenal Ileus. Med. Press and Circular, vol. xcvii, p. 339, 1924.
Konjetzney: Deutsche Zeitsch. f. Chir., vol. ccxxviii.
Kostlivy: Mitt. Grenzgeb. Med. und Chir., vol. xlii.
Laffer: Acute Dilatation of the Duodenum. ANNALS OF SURGERY, vol. xlvii, p. 390, 1908.
Lane: Duodenum and Chronic Intestinal Stasis. Surg., Gynec., and Obst., vol. xii, p. 221, 1911.
Idem: Kinks in Intestinal Stasis. Brit. Med. Jour., April 22, 1911.
Idem: Kinks in Intestinal Stasis. Practitioner, vol. xcii, p. 301, 1914.
Lapenna: Radiol. Med., vol. xiii.
Lebert: Quoted by Melchior.
Leveuf: Rec. de Chir., vol. xlix, p. 33.
Lewin: New Orleans Med. Jour., vol. lxxvi.
Luckart, Philips, and Carlson: Am. Jour. Phys., vol. l, p. 57, 1919.
Marx: Rinask. Med., vol. viii, 1931.
Mayer: Quoted by Melchior.
Mayo: Disputed Problems in Colon Surgery. Am. Jour. Med. Sci., vol. cxlv, p. 157, 1913.
McDonald: Congenital Duodenal Dilatation. *Ibid.*, vol. cxlvi, p. 28, 1919.
McKenty: Chronic Duodenal Stasis. Surg., Gynec., and Obst., vol. xxxviii, 1924.
McConnell, and Hardman. Quoted by Bell, Keith and Keith.
Melchior: Neue Deutsche Chirurgie, Stuttgart, 1917.
Idem: Archiv. der klin. Chir., pp. 125 and 129.
Melendez: Rev. Med. de Chili, vol. lvi.
Merkel: Quoted by Melchior.
Meyer: Klin. Wchnschr., 1922.
Moinehan: Disappointments after Gastro-enterostomy. Brit. Med. Jour., vol. ii, p. 33, 1919.
Morley: Lancet, vol. ii, p. 1685, 1913.
Idem: Brit. Jour. of Surgery, 1925.
Morris: American Med., vol. x, p. 95, 1905.

Morton, and Sullivan: Duodenal and Ileal Obstruction. Arch. Surg., vol. xxi, p. 531, 1930.
Nagel: The Cysto-duodenal Fold. Surg., Gynec., and Obst., vol. xxxvii, p. 365, 1923.
Neff, and Haden: Am. Jour. Dis. of Child., vol. xxx, p. 82, 1925.
Nesbitt: Chronic Duodenal Obstruction. N. Y. Med. Jour., vol. cxvi, p. 651, 1922.
Neuber: 12 Tagung der Ungarischen Geselschaft für Chirurgie.
Niles: Chronic Duodenal Ileus. Am. Jour. Med. Sci., vol. clxiv, p. 328, 1925.
Ochsner: Constriction of the Duodenum. ANNALS OF SURGERY, vol. xliii, p. 80, 1906.
Opel: Periduodenitis. Wratchebraja Gaseta, vol. xiii, 1914.
Quain: Chronic Duodenal Obstruction. N. Y. Med. Jour., vol. cxvi, p. 561.
Quimby: Am. Jour. Roentgenology, vol. i, p. 399, 1914.
Ralcoczi: Chronic Stasis in the Duodenum. Am. Jour. Roentgenol., vol. xii, p. 246, 1924.
Rembold: Oesterr. Zeitschr. für Kinderheilk., vol. cxxiv, 1865.
Rubin: Surg., Gynec., and Obst., vol. xii, p. 117, 1911.
Riedel: Quoted by Melchior.
Salotti: Ann. Med. Nav. e Colon., No. 2, 1928.
Sanctis, and Cray: Am. Jour. Dis. of Child., vol. xxxvii, 1929.
Schlecht: Symptome der Duodenalstenose. Munch. Med. Wchnschr., vol. lxiii, p. 1353, 1916.
Schoemaker: Periduodenitis. Surg., Gynec., and Obst., vol. li, p. 840, 1930.
Idem: The Red Stomach. *Ibid.*, vol. xl, p. 305, 1925.
Schoemaker, and Harlon: Calif. State Med. Jour., vol. xix.
Schomacher: Duodenum Chirurgie. Bruns Beitr., vol. lxxi, p. 482, 1910.
Shattuck, and Imboden: Chronic Intermittent Duodenal Ileus. Jour. Am. Med. Assn., vol. xcviii, p. 943, 1932.
Shroder: Jour. Am. Med. Assn., vol. lxxviii, p. 1039, 1922.
Silberman: Jahrbuch für Kinderheilkunde, vol. xviii, p. 420, 1882.
Slocum: Arteriomesenteric Occlusion. Surg., Gynec., and Obst., vol. xliv, p. 359, 1927.
Smith: Guy's Hospital Reports. Vol. lxxx, 1930.
Solem: Duodenal Obstruction and Gall-bladder. Med. Clin. N. A., vol. ix, 1926.
Stavely: Chronic Gastromesenteric Ileus. Surg., Gynec., and Obst., vol. cclxxxviii, 1910-1911.
Summers: The Dilated Duodenum. ANNALS OF SURGERY, vol. lxxx, p. 576, 1928.
Sundlein: Horns Archiv., p. 120, 1830.
Suslow: Neue Deutsche Chir., vol. viii, p. 9, 1930.
Taylor: Anomalous Abdominal Membranes. ANNALS OF SURGERY, vol. lxxv, p. 513, 1922.
Tellgmann: Med. Wchnschr, 1924.
Teschendorf: Deutsche Med. Wchnschr., 1925.
Tinklam: Boston Med. Jour., vol. clxxxviii.
Tisdall: The Sodium Ion in Tetany. Jour. Biol. Chem., vol. liv, p. 35, 1922.
Vadder: Rev. de Chir., vol. lxvi.
Valls: Relation of the Duodenum to the Right Colic Artery. Rev. de Chirurg., vol. v, p. 209, 1926.
Vanderhoof: Dilatation of the Duodenum. Jour. Am. Med. Assn., vol. lxix, p. 510, 1917.
Verbyke: Chronic Duodenal Stasis. South. Med. Jour., vol. xvii, p. 653, 1924.
Wade: Surg., Gynec., and Obst., vol. xvii, p. 184, 1913.
Walko: Verh d. 6 Konf. d. Wiss. Med. St. Petersburg, 1921.
Waugh: Consequences of Mobile Colon. Brit. Jour. Surg., vol. vii, p. 343, 1920.
Whipple, *et al.*: Intestinal Obstruction. Jour. Exp. Med., vol. xix, p. 144, 1914.
Weber: Machr. Kinderheilk., vol. xliii.
Weiss: Deutsche Med. Wchnschr., vol. xlviii.
Wilkie: Chronic Duodenal Ileus. Brit. Jour. Surg., vol. ix, p. 204, 1921-1922.
Idem: Am. Jour. Med. Sci., vol. clxxiii, p. 643, 1927.
Idem: Proc. Staff Meetings Mayo Clinic, 1929.
Wolfer: Chronic Duodenal Obstruction. Radiology, vol. ix, p. 39, 1927.

OPERATIVE MORTALITY IN INTESTINAL OBSTRUCTION

By Frederick Christopher, M.D., and W. Kenneth Jennings, M.D.
of Evanston, Ill.

From the Evanston Hospital and the Northwestern University Medical School

No apology need be offered for further study of intestinal obstruction. Not only is the operative mortality extremely high (in the neighborhood of 45 per cent.), but moreover, there seems to have been no improvement in this mortality in the last thirty-five years. Although the statistics of various clinics are not always strictly comparable because of the method of selection of cases, a consideration of these figures gives an excellent idea of the gross mortality. Table I shows a mortality in 2,345 collected cases of 46.5 per cent. This number includes 1,000 cases collected by Gibson[6] from the literature of 1888 to 1898 which have a mortality of 43.2 per cent. Recently McIver[7] reported 335 cases from the Massachusetts General Hospital with a mortality of but 31 per cent. This series, however, apparently does not include paralytic ileus. Other figures are Brill,[8] 124 cases with 36 per cent. mortality; Tuttle,[9] 150 cases with 50 per cent. mortality; Souttar,[10] 3,064 cases with only 32 per cent. mortality and Braun and Wortman,[11] 379 cases with 39 per cent. mortality.

Table I

Comparative operative mortality in intestinal obstruction at different clinics

Clinic	Cases	Mortality
EVANSTON HOSPITAL (10-year period). Collected by Christopher, F., and Jennings, W. K.	127	44.9%
JOHNS HOPKINS HOSPITAL (10-year period), Finney, J. M. T.[1]	217	35.0%
NEW YORK HOSPITAL (17-year period), Cornell, N. W.[2]	218	58.4%
LOS ANGELES COUNTY GENERAL HOSPITAL (5-year period), Vidgoff, I. J.[3]	266	45.9%
CHARITY HOSPITAL AND TOURN INFIRMARY, NEW ORLEANS (5-year period), Miller, C. Jeff[4]	342	60.0%
LEBANON HOSPITAL, NEW YORK (10-year period), Koslin, I. I.[5]	175	40.0%
VARIOUS HOSPITALS Collected from the literature 1888–1898 by Charles L. Gibson[6]	1,000	43.2%
Total	2,345	46.5%

The present study is based upon 127 proved cases of intestinal obstruction occurring at the Evanston Hospital in the ten-year period from 1922 to 1932. These cases were operated upon by twenty visiting surgeons of whom

five attended 79 per cent. of the cases. The relative operative mortality of the five men having the most cases is of interest and is shown in Table II.

TABLE II

Surgeon	Cases	Mortality
A	32	25%
B	20	45%
C	16	50%
D	14	43%
E	13	84%
15 surgeons	25	40%

The commonest etiology at the Evanston Hospital was adhesions and following this in order of frequency came neoplasms, volvulus, paralytic ileus, incarcerated hernia, intussusception, mesenteric thrombosis, and miscellaneous. This is somewhat at variance with the incidence of etiology shown in 1,332 cases collected from the recent literature and including the Evanston Hospital cases. In this series (Table III) the etiology in order of frequency was adhesions, hernia, miscellaneous, intussusception, malignancy and volvulus. In McIver's series strangulated external hernia occurred more frequently than obstruction due to adhesions.[7]

TABLE III

Incidence of etiology of intestinal obstruction in different clinics

Clinic	Adhesions	Hernia	Intussusception	Malignancy	Volvulus	Miscellaneous
Evanston Hospital	46	9	9	32	14	17
Johns Hopkins Hospital[1]	128	50	8	26	8	25
New York Hospital[2]	110	10	36	16	16	47
Los Angeles County General Hospital[3]	170	49	11	22	4	8
Charity Hospital and Tourn Infirmary[4]	98	96	42	17	34	55
Lebanon Hospital[5]	26	60	34	10	9	30
Total	578	274	140	123	85	182

The mortality according to etiology was studied in the Evanston Hospital cases and is shown in Table IV. The highest mortality was in mesenteric

TABLE IV

Operative mortality in intestinal obstruction at the Evanston Hospital

Cause of Obstruction	Cases	Deaths	Mortality
Adhesions	46	13	28.2%
Neoplasms	32	12	37.5%
Volvulus	14	7	50.0%
Paralytic Ileus	12	11	83.3%
Incarcerated Hernia	9	7	77.7%
Intussusception	9	2	22.2%
Mesenteric Thrombosis	3	3	100.0%
Miscellaneous	2	2	100.0%
Total	127	57	44.9%

TABLE V

Relationship of operative mortality to etiology at different clinics

Clinic	Adhesions		Hernia		Intussusception		Malignancy		Volvulus		Miscellaneous	
	Cases	Mort.	Cases	Mort.	Cases	Mort.	Cases	Mort.	Cases	Mort.	Cases	Mort.
Evanston Hospital	46	28.2%	9	77.7%	9	22.2%	32	37.5%	14	50.0%	17	94.1%
New York Hospital[2]	105	41.8%	10	30.0%	36	47.2%	16	75.0%	13	46.1%	38	65.8%
Los Angeles County General Hospital[3]	170	37.6%	49	60.0%	11	66.0%	22	68.0%	4	75.0%	8	12.5%
Charity Hospital and Tourn Infirmary[4]	98	58.1%	96	61.5%	42	52.4%	17	88.2%	34	58.8%	55	70.9%
Lebanon Hospital, New York[5]	26	34.6%	66	25.7%	34	32.3%	10	40.0%	9	44.4%	30	83.3%
Total	445	42.0%	230	50.0%	132	44.7%	97	59.8%	74	54.0%	148	71.6%

thrombosis and paralytic ileus and the lowest was in intussusception and the cases due to adhesions. In Table V is tabulated a series of cases from recently published statistics at representative clinics.

From Table V it will be noted that the percentage of mortality at the Evanston Hospital due to adhesions, intussusceptions, malignancy and volvulus was less than the average. The operative mortality in intussusception was 22.2 per cent. which compares very favorably with the general average of 44.7 per cent. The mortality in the adhesions cases was 28.2 per cent. as compared to the average of 42.0 per cent. On the other hand, the showing in hernia and in the miscellaneous cases was poorer than the average. Of interest in this connection was the fact that in McIver's[7] series the mortality for strangulated external hernias was but 18 per cent. in 147 cases.

Mere speed of operation did not seem to have a bearing in the Evanston Hospital Cases. (Table VI.) It is quite possible, however, that the cases

TABLE VI

Relationship of operating time to mortality in 109 cases of intestinal obstruction (all causes)

Operating Time	Cases	Deaths	Mortality
Under 30 minutes	14	6	42.8%
30 to 60 minutes	51	17	33.3%
Over 60 minutes	44	17	38.6%

in the poorest condition were operated upon most quickly. In the forty-six cases of intestinal obstruction due to adhesions there were previous operations in thirty-four cases. (Table VII.)

TABLE VII

Types of previous operations noted in forty-six cases of intestinal obstruction due to adhesions

A. *Single operations*

(1) Appendectomy	13
(2) Pelvic operations	9
(3) "Laparotomy"	3
(4) Cholecystectomy	2
(5) Herniotomy	2
(6) Gastroenterostomy	1
(7) For intestinal obstruction	1

B. *Two operations*
(most recent noted first)

(1) Hysterectomy; appendectomy	1
(2) Herniotomy; appendectomy	1
(3) Pelvic operation; "laparotomy"	1

C. *No operations* 12

Appendectomies and pelvic operations were the commonest offenders. It is of interest to note in this connection that 68 per cent. of Vidgoff's[3] cases of all types of intestinal obstruction had had previous operations. In seventy-

two of his cases there were mid-line incisions and in 62 per cent. of these there had been operations upon the female pelvic organs. Twenty-four and two-tenths per cent. of Miller's[4] cases and 40.0 per cent. of Finney's[1] had had previous operations.

The earlier the diagnosis is made and operation carried out the lower the mortality. This statement is graphically borne out in Tables VIII and IX.

TABLE VIII

Relationship of operative mortality to the duration of symptoms before operation in cases of obstruction due to adhesions

Duration of Symptoms before Operation	Cases	Deaths	Mortality
Under 24 hours	4	0	00.0%
24 to 48 hours	10	3	30.0%
Over 48 hours	25	9	36.0%
Not given	7	1	14.4%

TABLE IX

Relationship of operative mortality to duration of symptoms before operation in cases of intestinal obstruction due to volvulus

Duration of Symptoms before Operation	Cases	Deaths	Mortality
Less than 24 hours	2	0	00.0%
24 to 48 hours	6	2	33.3%
Over 48 hours	5	4	80.0%
Not stated	1	1	100.0%

The mortality in cases of intestinal obstruction due to external hernia was 66.6 per cent. and in internal hernia 100.0 per cent. Death followed all three of the cases due to incisional hernias. (Table X.)

TABLE X

Types of hernias causing intestinal obstruction

A. *External*	6	Deaths	4	Mortality	66.6%
(*a*) inguinal	2	Deaths	1	Mortality	50.0%
(*b*) femoral	1	Deaths	0	Mortality	00.0%
(*c*) incisional	3	Deaths	3	Mortality	100.0%
B. *Internal*	3	Deaths	3	Mortality	100.0%

(*a*) ileum through omentum (previous hysterectomy and appendectomy)
(*b*) ileum through mesentery of a Meckel's diverticulum
(*c*) not stated

An attempt is made to appraise the value of the various operative procedures in Tables XI, XII and XIII. The case for enterostomy is strengthened by Table XI which gives an operative mortality of 33.0 per cent. In the cases due to volvulus (Table XIII) the mortality was less where enterostomy was not done. In the intussusception cases (Table XII) the mortality was far less where the bowel was not opened.

TABLE XI

Relationship of operative mortality to operative procedures in cases of intestinal obstruction due to neoplasms

Type of Operation	Cases	Deaths	Mortality
Resection	5	2	40.0%
Resection and enterostomy	4	2	50.0%
Enterostomy only	18	6	33.0%
Enteroenterostomy	2	0	00.0%
Exploratory only	2	1	50.0%
No operation	1	1	100.0%

TABLE XII

Relationship of type of operation to mortality in cases of intestinal obstruction due to intussusception

Type of Operation	Cases	Deaths	Mortality
Resection	2	1	50.0%
Reduction of intussusception	7	1	14.3%

TABLE XIII

Relationship of operative technique to operative mortality in cases of intestinal obstruction due to volvulus

Procedure	Cases	Deaths	Mortality
Enterostomy	2	2	100.0%
No enterostomy	12	5	41.6%

BIBLIOGRAPHY

[1] Finney, J. M. T.: Surg. Gynec., and Obstet., vol. xxxii, p. 402, 1921.
[2] Cornell, N. W.: ANNALS OF SURGERY, vol. xcv, p. 810, 1932.
[3] Vidgoff, I. J.: ANNALS OF SURGERY, vol. xcv, p. 801, 1932.
[4] Miller, C. Jeff: ANNALS OF SURGERY, vol. lxxxix, p. 91, 1929.
[5] Koslin, I. I.: ANNALS OF SURGERY, vol. xcv, p. 821, 1932.
[6] Gibson, Charles L.: ANNALS OF SURGERY, vol. xxxii, pp. 486, 676, 1900.
[7] McIver, M. A.: Arch. Surg., vol. xxv, pp. 1089–1134, December, 1932.
[8] Brill: ANNALS OF SURGERY, vol. lxxxix, p. 541, 1929. (Quoted by McIver.)
[9] Tuttle: Boston Med. and Surg. Jour., vol. 192, p. 791, 1925. (Quoted by McIver.)
[10] Souttar: British Med. Jour., vol. ii, p. 1000, 1925. (Quoted by McIver.)
[11] Braun and Wortmann: Der Darmverschluss, Berlin, Julius Springer, 1924. (Quoted by McIver.)

SARCOMATOID FIBROMA OF THE SKIN

(PROGRESSIVE AND RECURRING DERMATOFIBROMA)

By Paul E. McMaster, M.D.

of Chicago, Ill.

FROM THE DEPARTMENT OF SURGERY OF THE UNIVERSITY OF CHICAGO

Sarcomata of the skin, although relatively rare, has been recognized for many years. However, in 1924, Darier[4] described a distinct, separate, relatively benign, but progressive and recurrent neoplasm of the skin under the title, "Progressive and Recurring Dermatofibroma, or Fibrosarcoma of the Skin." Since that time several similar cases have been studied and reported. One additional case will be presented in this article, making a total of thirty-nine such cases collected from the literature.

The distinguishing characteristics of this skin tumor are: Single origin (more rarely origin from two or three locations), usually located on the trunk; firm, painless, nodular in character in the early stage, becoming later, protruding, pedunculated or cauliflower-like masses, the growth being away from the body and remaining freely movable over the deep fascial layers; bluish-red discoloration of the overlying skin; histologically somewhat similar to fibrosarcoma, but invading only the adipose tissue, and not the deep fascial layers; never metastasizing, but recurrent if inadequately excised.

Following Darier's description of "Progressive and Recurring Fibromata, or Fibrosarcoma of the Skin," in 1924, Hoffmann,[7] one year later, made studies of similar cases and called the condition "Dermatofibrosarcoma Protuberans." Still later, in 1929, Mosto[13] suggested the title "Dermatoneuroma, or Dermatoschwannoma."

Studies of this condition have been made from a review of the literature (see Table) and the case to be reported:

Table of Published Cases

Case I.—Doctor Kartscher[20]: male, seventy-one years old. Duration of disease—sixty years. A protruding nodular mass, the size of an orange, with an ulcerated and bleeding surface located on the abdomen. No pain. Recurred each time after three excisions. Died of pneumonia.

Case II.—Doctor Kartscher: male, fifty-five years old. Duration of disease—six years. Orange sized tumor, nodular and protruding with a pale red and slightly eroded surface located on abdomen. No pain. History of trauma. Excised but recurred one and one-half years later.

Case III.—Doctor Kartscher: female, fifty-five years old. Duration of disease—seven years. Several nodules protruding from a plaque with reddish overlying skin and located on abdomen. No pain. History of trauma. Excised but length of cure not stated.

Case IV.—Doctor Pfeiffer[20]: female, sixty-one years old. Duration of disease—thirty-one years. Protruding nodular mass, size of a fist, located on abdomen. Some discomfort. Excised but length of cure not stated.

CASE V.—Doctor Pfeiffer: male, twenty-two years old. Duration of disease—fifteen years. Protruding and nodular mass located on abdomen with reddish overlying skin. No pain. Excised three times after three recurrences.

CASE VI.—Doctor Pfeiffer: female, fifty-three years old. Duration of disease—two years. No pain. Protruding and nodular mass with an ulcerated surface located on abdomen. History of trauma. Excised but length of cure not stated.

CASE VII.—Doctor Coenen[3]: female, sixty-one years old. Duration of disease—ten years. Small nodule on shoulder. Large ulcerated nodular mass located on thigh. No pain. Excision and no recurrence after three years.

CASE VIII.—Doctor Coenen: male, fifty-three years old. Duration of disease—twenty-eight years. Nodular mass somewhat protruding located on abdomen and covered with bluish red overlying skin. No pain. Excised and no recurrence after eight years.

CASE IX.—Doctor Arzt[1]: female, forty-five years old. Duration of disease—fifteen years. An ulcerated, bleeding, protruding and nodular mass located on left breast. Regional lymphadenitis. Excised but length of cure not stated.

CASE X.—Doctors Kuznitzsky and Grabisch[9]: female, forty-three years old. Duration of disease—twenty-five years. Ulcerated nodular mass five centimetres in diameter located in region of right clavicle. No pain. Excised. After five years two small nodules recurred.

CASE XI.—Doctors Kuznitzsky and Grabisch: female, twenty-eight years old. Duration of disease—fifteen years. Several pea to walnut-sized nodules protruding from region of breast with bluish red overlying skin. No pain. Pectoral muscle adherent in tumor. History of trauma. Excised but length of cure not stated.

CASE XII.—Doctors Kuznitzsky and Grabisch: male, twenty-two years old. Duration of disease—fifteen years. Nodular mass four centimetres in diameter located on left chest. Overlying skin dark red. Excised. No recurrence after two years.

CASE XIII.—Doctor Darier[5]: male, forty-eight years old. Duration of disease—three years. Nodular and protruding mass the size of hen's egg located on abdomen. No pain. Overlying skin purple. Treatment.—Diathermy, radiotherapy, thermocautery and excision. Recurred after the first three. Shortly after excision patient died of pneumonia.

CASE XIV.—Doctor Darier: male, sixty-seven years old. Duration of disease—forty-two years. Nodular, protruding mass, the size of palm of hand, located in inguinal region. Overlying skin reddish purple. No pain. Excision, with radiotherapy and diathermy, four times after recurrences. Death from gangrene of leg.

CASE XV.—Doctor Darier: female, forty-three years old. Duration of disease—four years. Nodular tumor mass size of palm of hand located in left lower abdominal region. Overlying skin dark red. No pain. Excised. Length of cure not stated.

CASE XVI.—Doctor Darier: male, forty-two years old. Duration of disease—nine years. Protruding nodular mass 10 by 20 centimetres located on abdomen. Overlying skin red. No pain. Treatment.—X-ray. Regressed temporarily but recurred.

CASE XVII.—Doctor Lutz[11]: male, thirty-two years old. Duration of disease—nine years. Nodular protruding mass 9 by 12 centimetres in left loin. Overlying skin rose to livid. No pain. Excised. Length of cure not stated.

CASE XVIII.—Doctor Weidman[18]: male, twenty years old. Duration of disease—seven years. Nodular mass size of silver dollar located on upper thigh. Overlying skin dark red. No pain. X-ray treatment and excision. Length of cure not stated.

CASE XIX.—Doctor Hoffmann[7]: male, fifty-seven years old. Duration of disease—twelve years. Protruding nodular mass size of fist located on right buttock. Bled once after trauma. Overlying skin reddish. No pain. Excised. No recurrence after two and one-half years.

CASE XX.—Doctor Hoffmann: male, sixty years old. Duration of disease—fifty years. Ulcerated and bleeding nodular mass size of an apple on flexor surface of right wrist. Slight pain. History of trauma. Excised. No recurrence after one year.

CASE XXI.—Doctor Hoffmann: male, forty-nine years old. Duration of disease—three years. Protruding nodular mass the size of an apple in the subscapular region. Overlying skin blue-red. Excised. No recurrence after one year.

CASE XXII.—Doctor Scomazzoni[15]: male, forty-three years old. Duration of disease—twenty-three years. Several protruding nodules on plaque located on right shoulder. Overlying skin red to purple. Treatment.—X-ray. Some improvement then progression of disease.

CASE XXIII.—Doctor Darier: male, forty-nine years old. Duration of disease—twenty-five years. Protruding walnut sized mass located in pectoral region. Overlying skin violaceous. No pain. Treatment.—Radium, no cure. Excised. No recurrence after two years.

CASE XXIV.—Doctor Senear, et al.[16]: female, forty-nine years old. Duration of disease—twelve years. Several protruding nodular masses hazel nut to hen's egg in size on lower right abdomen. Overlying skin ulcerated. Treatment.—X-ray and three excisions. No recurrences, after last excision, at two months.

CASE XXV.—Doctor Senear, et al.: female, fifty-nine years old. Duration of disease—one year. Protruding and nodular mass on upper outer chest wall. Overlying skin dead glistening white, partly ulcerated and bleeding. Excised. No recurrence after two years.

CASE XXVI.—Doctor Kiess[8]: male, twenty-eight years old. Duration of disease—two years. Nodular and protruding mass 10 by 12 centimetres in suprapubic region. Overlying skin telangiectatic. Excised. No recurrence after nine months.

CASE XXVII.—Doctor Willis[19]: female, forty-five years old. Duration of disease—twenty-four years. Nodular mass three centimetres in diameter on radial side of wrist. Overlying skin reddish-purple. No pain. History of trauma. Excised twice, once for recurrence. Length of cure not stated.

CASE XXVIII.—Doctor Willis: female, fifty years old. Duration of disease—one year. Nodular tumors left breast and back. (Twelve years previously these had been excised but had recurred one year before admission.)

CASE XXIX.—Doctor Willis. Author gives no case history except there were nodular elevations ranging from one to five centimetres in diameter. Diagnosis made microscopically.

CASE XXX.—Doctor Willis: male, forty years old. Duration of disease not stated. Ten nodules from two to ten centimetres in diameter located on abdomen. Overlying skin whitish. Tumors removed from abdominal wall eight years before but there was recurrence. No treatment given.

CASE XXXI.—Doctor Usher[17]: male, thirty-three years old. Duration of disease—eight years. Protruding and nodular mass in umbilical region. Overlying skin reddened. No pain. Excised. No recurrence after five months.

CASE XXXII.—Doctor Usher: female, thirty-five years old. Duration of disease—fifteen years. Nodular protruding masses on right thigh, abdomen and back. Inguinal lymphadenitis from superficial infection of thigh lesion. Overlying skin bluish-red. Biopsy done. X-ray treatment caused a regression.

CASE XXXIII.—Doctor Lapa[10]: female, fifty years old. Duration of disease—five years. Protruding nodular mass 6 by 11 centimetres in inguinal region. Overlying skin dark red. History of trauma. Excision. Length of cure not stated.

CASE XXXIV.—Doctor Mosto[13]: male, thirty-two years old. Duration of disease—twenty years. Five nodular and protruding tumors in inguinal region. Overlying skin slightly eroded and cyanotic. Biopsy. Treatment or result not mentioned.

CASE XXXV.—Doctor Scolari[14]: female, forty-five years old. Duration of disease—ten years. Protruding chicken egg sized nodule on abdomen. Overlying skin reddened and partly ulcerated. Excised. Recurred in one year.

CASE XXXVI.—Doctor Bezecny[5]: male, forty-eight years old. Duration of disease—thirty-eight years. Many protruding nodules on chest and abdomen. Overlying skin blue-red and ulcerated. Excised but recurred in five months.

CASE XXXVII.—Doctor Bezecny: female, thirty-one years old. Duration of disease—fifteen years. Plaque fifteen centimetres in diameter with protruding nodules located on back. Overlying skin red. Excised radically. Length of cure not stated.

CASE XXXVIII.—Doctor Bezecny: female, thirty-five years old. Duration of disease—three years. Protruding and nodular mass on abdomen and one on back. Overlying skin red. Excised. Length of cure not stated.

CASE REPORT.—White male, aged sixty-six, noticed two years before entering the University of Chicago Clinics a small, firm, painless lump in the upper right abdominal wall. This remained the size of a small cherry until two months before examination, at which time it commenced to increase fairly rapidly in size. The overlying skin was not discolored at first, but became dull red. There was no pain at any time, but the patient was conscious of the mass when he wore tight clothing. His general health was excellent. The patient was a healthy white male who presented the following positive findings: A few carious teeth, right inguinal hernia and a walnut-sized mass in the upper right abdominal wall. The skin overlying the mass was a dull reddish color. The mass protruded slightly and was composed of a nodule about three centimetres in diameter and a smaller nodule attached on the medial side, less than one centimetre in diameter. The whole mass was firm, not tender, but freely movable over the underlying fascia. There was no regional lymphadenopathy and no other skin lesions. Wassermann was negative.

The mass was widely excised, taking considerable normal tissue on all sides.

There has been no recurrence after eighteen months.

Pathological studies of this tumor revealed the following: *Gross.*—The mass was composed of two firm nodules, the larger measured three by two by two centimetres, and the smaller, which was attached to the larger, measured one centimetre in diameter. The growth was located in the corium and was quite firmly adherent to the overlying skin but not attached to the deep fascia. Increased resistance over the surrounding tissues was noted in cutting the nodules, and the surfaces made by cutting were grayish-white and traversed by a network of fine, interlacing fibrous strands. The tumor appeared to be definitely delimited from the subcutaneous structure, but in attempting to remove it, fine finger-like projections were seen to extend into the surrounding tissues. These were easily broken. The overlying skin was intact and discolored bluish-red, being a darker color on the papillary side. The epidermis and tumor were separable.

Microscopical.—The growth was situated in the corium and extended into the papillary layer of the skin. It penetrated the deeper tissues in finger-like projections which gradually frayed out in the adipose tissue. (Fig. 1.) The cells composing the tumor were mostly fusiform, quite densely packed and arranged in whirls and radiating from centre points. (Fig. 2.) In the peripheral portions the cells were less densely packed and gradually changed into normal tissue. Blood-vessels were present, but more numerous in the peripheral portions. There was no thrombosis and some of the vascular spaces contained red blood-cells. The growth extended into the papillary layer, which was somewhat flattened, but the neoplastic cells were less dense here than deeper. One section showed skin glands in the tumor near the periphery.

A study of the tumor under high-power magnification revealed fusiform and ovoid-shaped cells containing dark-stained nuclei which were elongated, spindle-shaped, ovoid and irregular. (Fig. 3.) There was a moderate amount of agranular, pale-staining cytoplasm. Two mitotic figures were found after a careful search was made. A delicate stroma of collagenic fibres was seen. The larger blood-vessels were lined by flattened endothelial cells, but in the tumor proper, smaller vascular spaces appeared to be, at least partly, lined by tumor cells. Red blood-cells were present in some of the spaces.

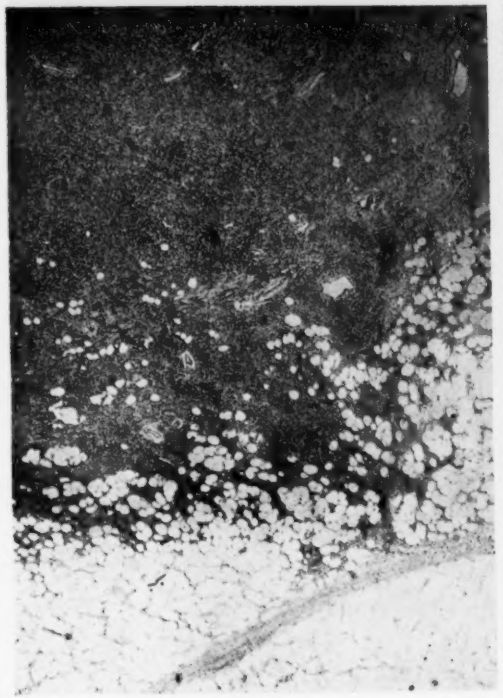


FIG. 1.—Low-power view showing the tumor process invading into the deeper adipose tissue, where it frays out. There is no encapsulation.

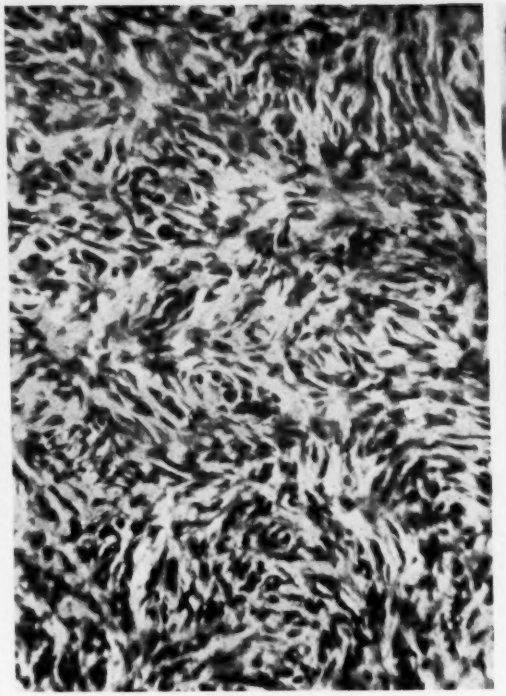


FIG. 2.—More detailed study showing the sarcomatoid arrangement of the cells.

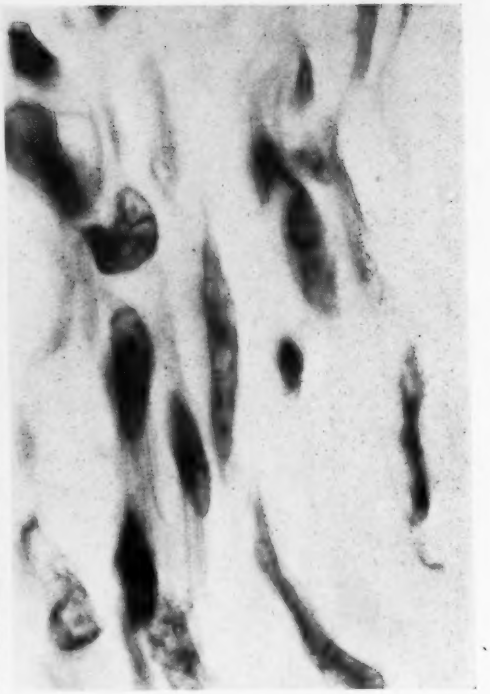


FIG. 3.—A few isolated cells under high-power magnification, showing their spindle, elongated and ovoid character.

The overlying epidermis was slightly flattened but intact. In two sections of several taken through the skin and underlying tumor there appeared a larger number of chromatophores both in the cutis and epidermis than normal, but these were located in the more peripheral portions where the tumor cells had not invaded the papillary layer. The chromatophores apparently had no relationship to the tumor as melanism was not found in the neoplastic cells. Extravasated red blood-cells were found in the papillary layer (accounting for the skin discoloration).

A Mallory connective-tissue stain showed a fine collagenic stroma throughout the tumor. Weigert's elastic tissue stain revealed an absence of this tissue from the tumor proper, although there was some present in the peripheral portions as well as in some of the larger blood-vessels. No atrophic or degenerated nerve fibres could be demonstrated in the tumor with a Freeman stain. A fat stain showed the tumor cells extending into the adipose tissue.

Studies of the reported cases and the one above reveal that the exact etiology of this condition is unknown. Trauma preceded only eight of the cases. Heredity played no part. Only one case was reported with a positive Wassermann, which, after vigorous anti-luetic treatment, showed no appreciable improvement in the neoplastic process.

The average age onset was thirty. The oldest age of onset was sixty-four, while the youngest was seven. The majority of cases occurred between the ages of twenty and forty-five. Males and females were about equally affected and the duration of the disease ranged from one to sixty years, the average duration being about sixteen years. General health of the patients was excellent.

The significance of an abnormal number of chromatophores, which were seen in the case reported here, as an etiological factor is conjectural. It does not seem logical to assume that these tumors are of nævus origin, as melanism has not been reported by previous observers and was not found in the tumor cells of this case. In a study of this subject Masson's[12] work on the origin of nævi should be consulted, in which he states nævi are of neurogenic origin.

The patients first noticed a small, painless, firm nodule in the skin, most frequently located on the abdomen, less often in the inguinal and chest regions and rarely on the extremities and back. No cases were reported with lesions on the head or below the thighs. The overlying skin at first is usually normal in color. Gradually the nodule increases in size, often by the coalescence of new nodules, forming a plaque, or "mother tumor," ranging in size from a few centimetres to as large as the palm of a man's hand. These plaques are not as a rule elevated but occasionally may protrude slightly. Nodular excrescences and protuberances develop on the plaque, ranging in size from cherries to large apples. These may be single or multiple, small or large, protruding nodules, and even large pedunculated, or cauliflower-like masses. The plaque may take several years to develop, while the nodular outgrowths are more apt to increase rapidly in size within just a few months. The characteristic feature, however, is that they grow outward, but never grow inward to invade the deeper fascial layers. There was

one exception to this, Kuznitzsky's[9] second case involved the underlying pectoralis muscle.

From the start the tumor masses are firm, painless, well defined, and during the entire course remain freely movable over the underlying deep fascia. They are adherent to the overlying epidermis.

Spontaneous regression in size of some of the nodules has been noted in a few cases. Also some softening has been noted in the nodules, most likely due to hæmorrhage from trauma, in the tumor substance.

Although normal in color at first, the overlying skin gradually becomes discolored, becoming dark bluish-red. At times, however, especially in the larger ones, the surface of the protruding tumors becomes eroded, with resultant ulceration. This is the result of mechanical rubbing of clothes and trauma to the surface. Following the appearance of an erosion, spontaneous hæmorrhage of varying amounts may occur, also tumor tissue may protrude through the erosion, presenting a dark red vegetating appearance. Secondary infection may supervene on an eroded surface and crusting of the lesion occur.

Regional lymphadenitis occurred in two cases but this was an inflammatory reaction following the infection of the tumor and not a metastatic invasion. The coincident or subsequent appearance of tumors of a similar nature on other parts of the body has caused some speculation as to skin metastasis, especially as in Usher's[17] second case the patient had a lesion on the thigh, abdomen and back, respectively. But from the lack of regional gland, skeletal or visceral metastases and the usual unilateral location of these tumors, the evidence points more to separate local stimuli producing the respective conditions than to metastases.

Pain is not present at any stage. Discomfort may follow the protruding tumors and the discharge, or varying amount of hæmorrhage may cause some inconvenience. The general health of the patients is unaffected by the growths.

Pathological studies of the reported cases are quite characteristic. On gross examination one or several nodules are seen, usually the latter. The size may vary from one or two to several centimetres in diameter. The tumors are located in the corium. The nodules cut with marked resistance and show the tumor to be firm, grayish-white and adherent to the overlying skin. The cut surfaces are traversed by a web-work of interlacing strands. The tumor appears to be definitely delimited but in attempting to remove it from its bed, fine finger-like projections are seen to extend into the surrounding tissue. (This explains the recurrence after incomplete excision.) These extensions are easily broken. The tumor is quite firmly adherent to the overlying epidermis but can be separated from it. The overlying skin is usually discolored bluish-red and is smooth, often thinned and at times its continuity is interrupted by surface erosions. This occurred in more than one-fourth of the reported cases. If this occurs the tumor may protrude through the skin in a dark hæmorrhagic vegetating mass. Also, the under-

lying tumor may be the seat of a varying amount of hæmorrhage, thus changing the normal grayish-white color to a dark red hæmorrhagic appearance. With the skin intact a noticeable feature is the darker appearance of the papillary side, compared to the superficial surface of the epidermis. In only one case was the tumor attached to deeper fascia or muscle. (See Kuznitzsky's second case.)

Microscopical studies show the tumor to be situated in the corium extending into the papillary layer. The tumor cells penetrate into the subcutaneous adipose tissue in finger-like projections, gradually fraying out as one looks into the deeper portions of the underlying fatty tissue, illustrated in Fig. 1. Under low magnification the tumor is composed of densely packed fusiform cells, arranged in whirls and bundles, as seen in Fig. 2. The cells are less densely packed in the peripheral portions of the growth and gradually fade into normal tissue. Blood-vessels are present, but more numerous in the peripheral portions. There is no thrombosis of the vessels and red blood-cells are present in some of the spaces.

The tumor growth extends into the papillary layer, which in some regions remains unchanged, in others flattened. The tumor cells in the papillary layer are as a rule less densely packed than deeper. The epithelium in some regions is thinned. When the tumor protrudes slightly, the epithelium is, as a rule, not thinned, but in the larger protruding masses the overlying epithelium is apt to be flattened.

Normal glands of the skin are usually absent from the tumor proper, but were occasionally noted.

A detailed study of the fusiform cells reveals a dark-staining nucleus, elongated, spindle-shaped, ovoid and irregular. There is a moderate amount of agranular, pale-staining cytoplasm. An occasional mitotic figure is seen, but they are not numerous.

The vascular spaces are for the most part lined by flattened endotheliel cells and occasionally contain red blood-cells. A few of the smaller vascular spaces appear to be at least partly lined by tumor cells.

A fine collagenic stroma is seen between the cells. This is well demonstrated by Mallory's connective-tissue stain. Weigert's elastic-tissue stain shows this tissue practically absent in the tumor proper, but present in increasing amounts as one passes to the more peripheral parts of the tumor. It is also present in the larger blood-vessel walls. Sections taken through the older, less actively growing parts of the tumor reveal similar but less densely packed cells, less hyperchromatic nuclei and considerably more collagenic matrix.

Areas of myxomatous swelling have been described but this is not a constant finding.

Complete surgical excision including a fairly wide zone of healthy skin and subcutaneous tissue has proved the only method of complete cure. Various other types of treatment, such as radiotherapy, thermocautery, diathermy and galvano-therapy, have not resulted in cures. The use of radiotherapy has

caused some regression in the nodules but recurrences have occurred. Incomplete surgical excision, leaving behind some of the finger-like projections into the subcutaneous tissue, have resulted in quite rapid recurrences, which is one of the characteristics of the tumor. Hence, for permanent cure, complete surgical excision followed by röntgenotherapy to inactiviate or destroy any of the tumor tissue remaining is the treatment of choice.

Since these tumors were first described seven years ago, a number of cases have been recognized and reported. Hence the author believes with other writers that the condition is probably fairly common. Similar tumors have likely been removed and a pathological report of "fibrosarcoma" or simply "fibroma" has been returned, without recognizing the true condition. Hertzler[6] states that he has had twenty-two fibrosarcomatous tumors of the skin of the trunk in twenty-five years. However, as he stated, a capsule is present and metastases occur, the classification of these tumors under the heading of this paper is doubtful.

The author agrees with Scolari[14] that the title Dermatoneuroma, or Dermatoschwannoma should be rejected, at least until further evidence is offered in support of a neurogenic origin. In support of a fibroblastic origin, the tumors show considerable collagen formation with Mallory connective-tissue stain.

The term fibromata does not seem adequate to describe these tumors, for they are not encapsulated, do invade the adipose tissue, and tend to recur following incomplete excision. On the other hand, fibrosarcoma in the usual interpretation suggests a malignant tumor which grows rapidly, invading the deep structures, producing metastases and often death. Hence, because of these reasons and histologically showing sarcomatoid tendencies, but not the malignancy of a fibrosarcoma, the title "Sarcomatoid Fibroma of the Skin," is suggested.

SUMMARY

(1) "Sarcomatoid Fibroma of the Skin," being sufficiently descriptive and not misleading, is suggested as the title for this distinct clinical and pathological entity.

(2) The condition is slowly progressive, not fatal, but recurrent if inadequately excised.

(3) Complete and wide surgical excision, followed by röntgenotherapy, is the treatment of choice.

BIBLIOGRAPHY

[1] Arzt, L.: Verhandlungen der Wiener dermatologischen gesellschaft. Arch. f. Dermat. u. Syph., vol. cxv, p. 18, 1913.

[2] Bezecny, R.: Dermatofibromatosis protuberans et progrediens. Arch. f. Dermat. u. Syph., vol. clxii, pp. 782–791, 1931.

[3] Coenen, H.: Granulationsgeschwülste und Sarkome. Beitr. z. klin. Chir., vol. lxiii, pp. 337–346, 1909.

[4] Darier, J., and Ferrand, M.: Dermatofibromes Progressifs et Récidivants, ou Fibrosarcomes de la Peau. Ann. de dermat. et de syph., vol. v, p. 545, 1924.

[5] Darier, J.: Un Nouveau cas de Fibrosarcomes de la Peau, opéré gueri. Bull. Soc. franç. de dermat., vol. xxxiii, p. 32, 1926.

[6] Hertzler, A. E.: Fibrosarcomatous Tumors of the Skin of the Trunk. Annals of Surgery, vol. lxxxiv, p. 489, 1926.

[7] Hoffmann, Erich: Über da Knollentreibende Fibrosarkom der Haut. (Dermatofibrosarkoma protuberans.) Dermat. Ztschr., vol. xciii, pp. 1–28, 1925.

[8] Kiess, Oscar: Ein neuer Fall von Dermatofibrome progressif oder Fibrosarcome. (Darier.) b. z. w. Dermatofibrosarcoma protuberans. (E. Hoffmann.) Dermat. Wchnschr., vol. lxxxvi, p. 1, 1928.

[9] Kuznitzsky, E., and Grabisch, A.: Über myxomatöse Fibrosarkome der vorderen Brustwand. Arch. f. Dermat. u. Syph., vol. cxxxi, pp. 24–32, 1921.

[10] Lapa, A.: Progressive and Recurring Dermatofibroma; or Dermatofibrosarcoma. Lisboa Med., vol. vi, pp. 355–376, 1929.

[11] Lutz, F.: Fibrosarkom. Schweiz. Med. Wchnschr., vol. lii, pp. 571–572, 1922.

[12] Masson, P.: Les Naevi Pigmentaires Tumeurs Nerveuses. Ann. d'anat. pathol., vol. iii, pp. 417–452, 1926; *ibid.*, vol. iii, pp. 657–696, 1926.

[13] Mosto, D.: Sobre una nueva interpretación de los Dermatofibromas de Darier. Semana méd., vol. xxxvi, pp. 855–859, 1929.

[14] Scolari, E. G.: Del Fibrosarcoma cutaneo. Gior. ital. di dermat. e sifil., vol. lxxi, pp. 1533–1558, 1930.

[15] Scomazzoni, T.: Contributo alla Clinica e Alla Istologia Dei Fibrosarcomi (Dermatofibromi) Cutanei. Gior. ital. di dermat. e sifil., vol. lxvii, pp. 115–135, 1926.

[16] Senear, F. E., Andrews, E., and Willis, D. A.: Progressive and Recurrent Dermatofibrosarcoma. Arch. of Dermat. and Syph., vol. xvii, pp. 821–832, 1928.

[17] Usher, B.: Progressive and Recurrent Dermatofibrosarcoma (Dermatofibrosarcoma protuberans). Brit. Jour. of Dermat., vol. xli, p. 363, 1929.

[18] Weidman, F. D.: Fibrosarcoma (?) of the Thigh. Arch. of Dermat. and Syph., vol. v, p. 421, 1922.

[19] Willis, D. A.: Recurrent Fibromatous Tumors of the Skin. Annals of Surgery, vol. lxxxvii, p. 945, 1928.

[20] Kartscher and Pfeiffer: Quoted from Scomazzoni.

ARSENICAL KERATOSES AND EPITHELIOMAS

By Gordon McNeer, M.D.

of New York, N. Y.

From the Service of Dr. Frank E. Adair at the Memorial Hospital of New York

Cutaneous changes as a result of arsenical therapy, while infrequent, are occasionally seen in large clinics. This study refers especially to arsenical epitheliomas being based on three such cases, with an additional case of arsenical keratosis.

Hutchinson[1] is usually credited with the first observations of the relationship between arsenical therapy and cancer, although Paris,[2] in 1825, discussed this condition among tinburners and smelters. Erasmus Wilson, in 1868, described arsenical keratosis in detail. In 1900, 3,000 people developed arsenical dermatitis in Manchester, England, as a result of drinking beer which had been sweetened with glucose containing arsenic. Since 1920, the number of authentic reports of arsenical epitheliomas has doubled. At that time MacLeod[3] reported fifteen cases; and Pye Smith has recently collected thirty cases.

Apparently the amount of arsenic taken is not of fundamental significance. Timberlake[4] discusses acute skin reactions which have followed the ingestion of a single dose of three drops of Fowler's solution. In other cases the lesions have developed after only ten to thirty years' use of this drug. Hamilton's[5] case had been treated with Fowler's solution for thirty years. Of our patients, the one who ingested the smallest total dose (five drops daily for three weeks) suffered the most serious consequences; whereas the patient treated with the greatest amount of arsenic developed merely keratoses. Semon[6] quotes MacLeod as saying that the average incidence of cutaneous manifestations is two years after ingestion of the drug. Among our four cases the shortest period of elapsed time was one and one-half years; the longest was seventeen years; and the average latent period was seven and one-half years.

According to Osborne,[7] however, the chemical form of arsenic is of fundamental importance. As a result of microchemical studies he has concluded that the quintavalent group, as found in Fowler's solution, has a predilection for ectodermal structures, such as skin, sweat glands, hairs, *etc.* Epitheliomas therefore occur as a result of arsenic being deposited in the papillary and subpapillary layers of the skin. Osborne has further shown that the amount of arsenic quantitatively determined in the tissues is proportionate to the severity of the dermatitis. Muller[8] believes that there is an individual susceptibility of the involuntary nervous system to similar concentrations of arsenic in the blood and tissues, a further indication that ectodermal structures other than skin are similarly affected. As a result of their work on arsenical tumors in rats, McJunkin and Cikrit[9] demonstrated the rôle of arsenic as an aid to the growth of tumors. Ewing[10] has described the close association of arsenic with the formation of acanthomas.

Three types of lesions may occur; dermatitis, keratoses, and epitheliomas. Acute arsenical dermatitis leaves a brownish pigmentation which may last for years, at first accompanied by scales and fissures, numbness and tingling of

the part involved. The keratoses affect mainly the palms and soles, extensor surfaces, elbows and knees; simulating closely the distribution of psoriasis. Many of the lesions are small, flat, erythematous plaques. Others are larger, one to two centimetres in diameter, raised and hard, showing marked thickening and change in the skin surface. Some lesions are manifested by scales, fissures, and crusts, with rolled borders. According to Adair a person afflicted with arsenical keratosis can be recognized by palpation of the palms and soles, which feel as though one were palpating many sharply pointed tacks protruding from beneath the epidermis.

Arsenical epitheliomas are as a rule grade I or grade I plus squamous-cell carcinomas. They are of a low grade of malignancy as evidenced by keratinization and pearl formation. Andrews[11] states they may also be of the basal-cell variety, both types of lesions occurring in the same patient. Metastasis to lymph-nodes occurs very late in the disease. In one of our patients the disease has been present for at least fifteen years, but as yet there is no regional lymph-node involvement. Sutton[12] has said that this form of carcinoma does not affect lymph-nodes, but in one of our patients with arsenical epithelioma of the right thumb, the disease metastasized to the right axilla, as proven by axillary dissection and subsequent histological study. Milch[13] believes that arsenical epithelioma has a low grade of malignancy, stating that the arsenical factor producing the epithelioma may lead to early cornification and hence restraint of growth. The histological picture is one of extensive infiltration of the cutis and subcutaneous tissues by columns of new cells, some of which lie definitely within the lymphatics.

The treatment of these lesions depends on the extent of the disease and the form encountered, and therefore the therapy in each case is an individual problem. When limited to a dermatitis, sodium thiosulfate, injected intravenously in amounts up to one gram daily for six days, has proven successful. Bugg and Folkoff[14] have reported one such case, and Halliday and Sutherland[15] others. Keratoses respond fairly satisfactorily to low-voltage röntgen therapy, and radium applied as a bulb or plaque. Frequently, such methods leave merely a soft pliable scar. Arsenical epitheliomas tax the ingenuity of both the surgeon and röntgenologist, if multiple lesions are encountered. Milch reports a satisfactory two-year cure as a result of surgical excision and subsequent skin grafting of a typical squamous-cell carcinoma of the heel. The case which presents multiple lesions is not so easily solved. One of our patients had a lesion of the right hand so deeply ulcerated that amputation at the mid-forearm was necessary. When dealing with the smaller lesions the electric cautery was found of great value. The low-voltage röntgen rays have proven to be one of our most valuable types of irradiation of the multiple lesions. Adair and Bagg[16] have described the use of mustard gas in the treatment of arsenical keratoses and epitheliomas. One minim of 10 per cent. mustard gas in absolute alcohol was placed on each of two lesions on the right arm and chest wall. (Fig. 1.) In six weeks there were soft pliable scars, and in twelve months there was no evidence of disease. Many lesions so treated

in another patient likewise disappeared. The use of mustard gas solution should therefore be added to the therapeutic armamentarium.

Prognosis as to life is favorable when dealing with arsenical epitheliomas because these lesions are of a low grade of malignancy. In Case I the patient first noticed the lesions on December 3, 1929, and our last examination on September 23, 1931, revealed no evidence of disease, a period of almost two years. In Case II there were definite keratotic lesions in 1916, but the diagnosis of cancer was not established histologically until 1925. This patient is living without disease seven years later. In Case III the patient first noticed

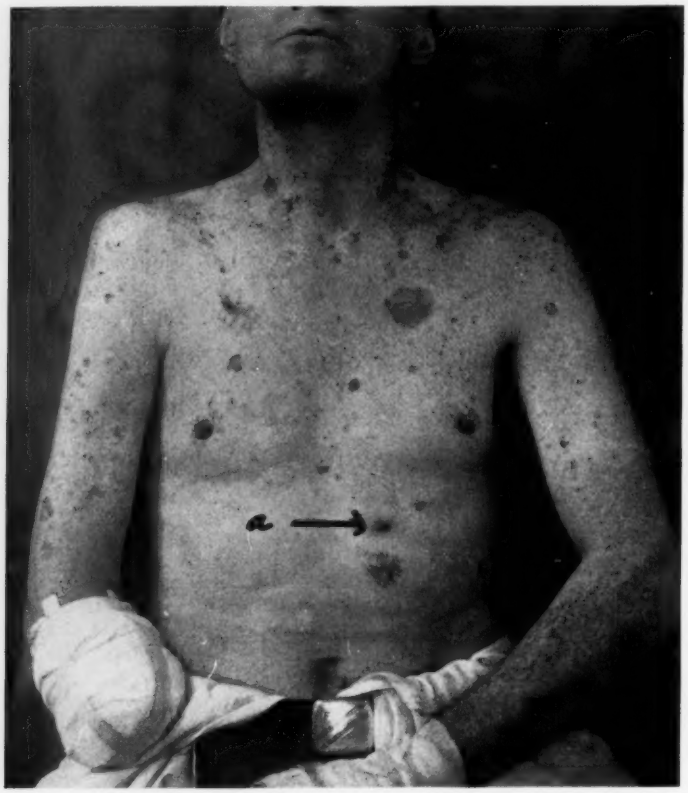


FIG. 1.—(Case I.) Showing the distribution of the lesions over trunk, neck, and arms. Arrow points to an ulcerated squamous-cell epithelioma. The lesions as a rule are quite superficial and ulceration does not take place early.

the lesions in 1925 and was later found to have an axillary node involvement. The feature of this disease is the great multiplicity of lesions that develop, for as one group is cured, a new crop appears elsewhere. Being aware of their low grade of malignancy the therapeutist treats each new lesion as it appears, fairly secure in the knowledge that the patient will survive many years.

CASE REPORTS.—CASE I.—A. R., male, aged thirty-one years, white, single, admitted to Memorial Hospital on December 3, 1929. This man had received thirty drops of Fowler's solution daily for six months in 1912. In May, 1929, a small tumor near the anus was removed at the Walter Reed Hospital in Washington, D. C., where the pathological report was squamous-cell carcinoma. In August, 1929, many small lesions

appeared on the body. One was excised from the right chest at the Naval Hospital in Washington, D. C. The pathological report was likewise squamous-cell carcinoma.

Examination showed present: (1) Operative scar one inch to the right of the anus. (2) On the back, chest, extensor surface of the right ankle were numerous skin lesions, varying from one-half to one and one-half centimetres in diameter. The edges were slightly rolled, raised, crusted, and pinkish-gray in color. All were freely movable. (3) Over the back were numerous small acneiform red papules. (4) On the dorsal surfaces of both hands, most marked on the right, and on the palms, were multiple flat warts. A slide from Walter Reed Hospital showed "squamous-cell carcinoma, grade II, radio-resistant."

With the diagnosis of arsenical keratoses and epitheliomas, there was presented a treatment of one drop of 10 per cent. mustard gas in absolute alcohol on the lesions of chest wall and arm. This was done December 5, 1929.

Follow-up.—January 20, 1930. Lesions healed with soft scars. Last note made on September 23, 1931: "No evidence of disease."

FIG. 2.—(Case I.) Amputated hand and forearm, showing the great number of separate and coalescent lesions. On the ulnar side the ulceration is deep. Numerous keratotic areas are noted over dorsum of the hand. The skin is very dry and rough.

CASE II.—A. F., white, single, male, aged fifty years, admitted to Memorial Hospital November 30, 1929. The man had been treated for psoriasis in 1914 by means of five drops of Fowler's solution three times a day for three weeks. He was seen by Darier, in France, who treated the lesions first seen in 1916 by radiation. This therapy resulted in their disappearance. More lesions appeared in 1925 and the pathological report at that time was carcinoma. Since then numerous other manifestations of arsenical toxicity occurred as described in detail below.

Examination showed present: (1) A large ulcerated area on the dorsal surface of the right hand extending to the flexor surface; a total of twenty square centimetres. (Fig. 2.) (2) The dorsum of the left hand was likewise ulcerated and bore several small crusted lesions. (3) Over the skin of the trunk and upper extremities there were many reddish-pink, crusted lesions, measuring from one-half to two centimetres in diameter. (4) An area of telangiectasis on the back and chest where radium had been applied by Darier.

The pathological report was: "squamous-cell carcinoma, grade I, radio-resistant."

Treatment.—(*a*) Surgical: Mid-forearm amputation of the right arm to get rid of a large, foul, sloughing lesion, and a useless hand. This was performed December 18, 1929.

(*b*) Mustard gas was applied to lesions on the left hypogastrium, right anterior chest, left lumbar region, head, right arm, neck, and back; thirteen lesions in all treated on January 3, 1930. By January 30, 1930, three lesions had completely regressed. Two months later many of the others were greatly improved.

(*c*) Radium emanation: 16,000 millicurie hours to the dorsum of the left hand; 12,000 millicurie hours in all to lesions of the abdomen, right arm, calf, and shoulder.

(*d*) X-rays: Three treatments of 900 r. each, at 140 kv. to thoracic lesions. Five similar treatments to the left neck, shoulder, thigh, and wrist.

(*e*) Electro desiccation of lesions on the left hand.

Follow-up.—June 28, 1932. Many of the lesions so treated were improved, but there was a definite increase in epitheliomas on the back, and a new ulceration near the old one on the left hand. November 8, 1932, ulceration on the left hand had definitely increased and some form of surgical intervention must now be definitely considered.

CASE III.—M. D., white, married, male, aged thirty-five years, admitted to Memorial Hospital September 2, 1925. The patient had been taking medicine, chemically proven to contain arsenic, since 1917. About January, 1925, he noticed on the right thumb a wart-like growth, which grew rapidly, becoming scaly and painful.

When admitted examination showed multiple areas of keratoses on palms and backs of both hands, right thumb, and soles of feet; an enlarged lymph-node in the right axilla.

The pathological report of the axillary node after removal was "squamous-cell carcinoma."

The diagnosis was arsenical keratoses and epitheliomas with metastasis to axillary node.

The lesions on palms were treated January 7, 1925, with radium emanation. No evidence of disease by February 25, 1927. A surgical dissection of the right axilla removed the affected node which later by histological study was found to be the subject of squamous-cell carcinoma.

Radium emanation applied with the bulb was administered in fifteen treatments of 450 millicurie minutes each on the lesions described above.

Follow-up.—Note on September 23, 1932, "None of the warty lesions on the hand show malignant change. The keratotic lesions have not responded satisfactorily to treatment."

CASE IV.—A. L., white, single, male, aged fifty years, admitted to Memorial Hospital September 4, 1929. This man had received arsenic therapy for anæmia in 1904. Several years later he developed the lesions described below.

(1) Scattered thickly over the back, palms of the hands, and both surfaces of the feet, were numerous small lesions; the majority being a few millimetres in diameter, reddish and not raised. Others were one centimetre in diameter, showing marked thickening and changes in skin surface. (2) On the left hand were two small ulcerated lesions, each about four millimetres in diameter.

No specimen was removed for histological study as the lesions had not undergone malignant change. *Diagnosis.*—Arsenical keratosis.

Treatment.—Radium emanation applied with the bulb, totalling 1,775 millicuri minutes, to the hands and ankles. Further radiation therapy by this method was applied to the other lesions described above, using a total dose of about 8,000 millicurie minutes.

Follow-up.—Last note on July 27, 1931, stated that the right foot and ankle were decidedly improved, but not entirely healed. Patient has since been extremely uncoöperative and failed all appointments.

Summary.—(1) Four cases are presented: One of arsenical keratosis, and three of arsenical epidermoid carcinoma combined with keratoses.

(2) The amount of arsenic ingested, while not fundamentally important, has usually been large, and has been taken over a long period of time. The quintavalent form is the type which produces keratoses and epitheliomas because of its predilection for ectodermal structures.

(3) Three kinds of lesions are produced: dermatitis, keratosis, and epithelioma.

(4) The epitheliomas grow slowly, are of a low grade of malignancy, and but moderately radio-sensitive. Metastasis to the regional lymph-nodes occurs, but late in the disease, as exemplified in Case III. Prognosis as to life is fairly good. Recurrence and progressive crops of lesions appear.

(5) Treatment is a difficult problem. It is frequently necessary to employ several therapeutic agents on the same patient. Surgical excision can be but rarely utilized as there are too many lesions to treat. As the lesions are usually superficial, the low-voltage X-rays or the mustard gas solution have given the best results in our cases. The radium plaques of 1,000 millicurie hours applied to each lesion have also been of benefit.

(6) Frequent observation of the patient is of great importance.

The author is indebted to Dr. Frank E. Adair for helpful suggestions and for permission to report these cases.

BIBLIOGRAPHY

[1] Hutchinson, J.: Brit. Med. Jour., vol. xi, p. 230, 1887.
[2] Paris, J. A.: Pharmacologica, vol. xi, p. 70, 1925.
[3] MacLeod, J. M. H.: Diseases of the Skin, pp. 714–716, 1920.
[4] Timberlake, H. P.: Chronic Arsenical Dermatosis, U. S. Veterans Bureau Bulletin, vol. v, pp. 678–681, 1929.
[5] Hamilton, G. R.: Arsenical Keratosis and Epitheliomas, Brit. Jour. Dermat., vol. xxxiii, p. 15, 1921.
[6] Semon, H. C.: Arsenical Keratosis Followed by Carcinoma, Brit. Med. Jour., vol. ii, p. 975, November 18, 1922.
[7] Osborne, E. N.: Microchemical Studies of Arsenic in Arsenical Dermatitis, Arch. Derm. and Syph., vol. xviii, pp. 37–49, July, 1928.
[8] Muller, E. F.: Arsenical Lesions of the Skin. Arch., Dermat., and Syph., vol. xv, pp. 186–193, February, 1927.
[9] McJunkin, F. A., and Cikrit, M. F.: Arsenic Tumors in Rats. Proc. Soc. Exper. Biol. and Med., vol. xxvii, pp. 179–181, December, 1929.
[10] Ewing, J.: Neoplastic Diseases, p. 867, 1928.
[11] Andrews, G. C.: Diseases of the Skin, pp. 320–323, 1930.
[12] Sutton, J. B.: Brit. Med. Jour., vol. ii, p. 788, 1916.
[13] Milch, H.: Resection of Arsenical Epithelioma. Plastic Reconstruction of Heel. Am. Jour. Surg., vol. xvi, pp. 89–93, April, 1932.
[14] Bugg, C. R., and Folkoff, C.: Arsenic Dermatitis in a Child, Treated with Sodium Thiosulfate. Johns Hopkins Hospital Bulletin, 1924.
[15] Halliday, A. M., and Sutherland: Brit. Med. Jour., vol. xv,[1] p. 407, 1928.
[16] Adair, F. E., and Bagg, H.: Experimental and Clinical Studies on the Treatment of Cancer by Dichlorethyl Sulphide. ANNALS OF SURGERY, pp. 190–199, January, 1931.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD MARCH 8, 1933

The President, Dr. John Douglas, in the Chair

THYROID NODULES IN THE LATERAL NECK REGION

Dr. John M. Hanford presented a young woman because her disease was rare; because it exemplified one of the ever-increasing surprises encountered in the neck; because clinically it resembled enlarged lymph-nodes; because the gross appearance at operation suggested a melanoma; because it emphasized the value of a biopsy before undertaking treatment of neck swellings when the diagnosis cannot otherwise be established. This case was the first of a group of three with the same diagnosis in the files of the Presbyterian Hospital. They all came recently within a period of twenty months when none had appeared during the many preceding years. All were females.

October 31, 1930, this young woman, then sixteen years of age, applied at the Vanderbilt Clinic on account of a swelling in the left side of the neck of some four years' duration. She was born and had always lived in New York City. Two sisters had enlarged thyroid glands which subsided under medical care. She herself first noted thyroid enlargement at the age of eleven, which remained constant until it slowly decreased at the age of sixteen. But she noticed that the lateral neck swelling increased as the goitre decreased. Pain in the left ear finally brought her to seek medical aid. She has never had symptoms suggesting hyperthyroidism. Her history and previous state of health were otherwise unimportant. She was a slender, thin, delicate-appearing girl with continued moderate tachycardia, with a simple, smooth, adolescent goitre of small size and with a group of nodules in the left side of the neck, beneath and behind the sternomastoid muscle. These nodules varied in size from one to three centimetres in diameter; were movable, discrete and rounded; not very firm and not very tender. They extended from just below the mastoid process to the middle of the clavicle, corresponding to a chain of deep and posterior cervical lymph-nodes. They were separate from the thyroid gland. They were less firm than most tuberculous nodes, but suggested rather the relatively soft nodes often seen in Hodgkin's disease. Except for the small goitre and the moderate tachycardia, there were no signs of hyperthyroidism. The general physical examination was otherwise essentially normal.

Laboratory studies showed the urine and a complete blood count normal; the Wassermann test negative; the basal metabolism test, minus 10 per cent. X-rays showed no evidence of calcification in the neck or chest, no mediastinal shadows, no evidence of substernal thyroid tissue, and showed the lung fields clear.

November 8, 1930, two of the nodules from the lower part of the neck were removed. They were thought then to have been lymph-nodes. The striking finding was a blackish appearance of the nodules, subsequently found

to have been due to hæmorrhage in the nodules. They were moderately firm but not hard. Each was encapsulated and beneath the capsule were deep purple areas. They averaged 2.5 centimetres in diameter. On cut section they were found composed of moderately firm white tissue with extensive areas of soft purple tissue apparently hæmorrhagic. In one or two places were cystic spaces filled with dark, red fluid. The microscopic picture was essentially that of an adenoma of the thyroid gland with hæmorrhages into some of the acini, large areas of degeneration and areas of hæmorrhage in the stroma. No lymph-node structure was seen. Doctor Stout commented on the slides as follows: The problem is to decide whether this is the primary growth of a remnant of lateral thyroid or whether it is a metastasis from a growth in the thyroid gland itself. Apparently normal thyroid tissue has been known to metastasize. There is nothing in these slides to suggest that these are metastases in lymph-nodes. He concluded, therefore, that these were primary growths from remnants of the lateral thyroid anlage.

A radical excision of all the apparent disease was made November 25, 1930. All of the disease was removed except a possible nodule which lay behind the innominate vein too inaccessible for removal; but this is merely suspicion. The incision extended from the mastoid process downward nearly to the middle of the clavicle and then curved forwards towards the mid-line. The nodules were very numerous and were placed along the internal jugular vein and out in the posterior triangle of the neck. They were removed *en masse* with the vein sheath and with the fatty and the areolar tissue in which they lay. Efforts were made to preserve the accessory nerve and the muscular branches of the cervical plexus.

The post-operative course was satisfactory. During the two years since the operation, she has reported to the Follow-up Clinic at intervals. She has presented a slight diffuse thyroid enlargement with no evidence of hyperthyroidism. A short course of iodine treatment had no effect. She has been well but under-weight and rather pale. When last seen she had slight thyroid enlargement and there was a three-quarters centimetre firm nodule which appeared as if it lay in the left lobe of the gland. The trapezius muscle is not paralyzed nor atrophic. The scar is slightly widened and ridged.

The other two patients mentioned above were fifty-two- and fifty-nine-year-old women. One had had the lump in the neck for sixteen years at least, the other for twenty-five years. The latter presented a large visible mass of very large round nodules in the lower part of the neck. Both were treated by radical excision and have done well since operation. These two patients did not show the extensive hæmorrhages and blackish discoloration of the young woman's nodules. The microscopic pictures were those of thyroid adenomata.

Dr. William Barclay Parsons said that these cases of Doctor Hanford were all cases with lateral aberrant thyroid tissue. Aberrant thyroid tissue may be found in other situations. If one considers the base of the tongue and the thyroglossal tract as abnormal sites for thyroid tissue, in spite of their normal embryological relationship to the thyroid, then thyroid tissue here, as well as the more infrequent separate and distinct intrathoracic masses, must also be kept in mind. The thyroid tissue in these situations is of considerable importance when hyperthyroidism persists following the ordinary partial thyroidectomy. In view of the fact that the histological composition of aberrant thyroid tissue is frequently of the papillary type, and that car-

cinoma is felt to follow adenomata composed of this cellular arrangement, one is forced to consider the relatively great danger of carcinoma in any of the tumors of aberrant thyroid tissue. Cattell, of Boston, reported before the meeting of the American Medical Association in June, 1931, thirteen cases of tumors of the lateral aberrant variety in which there were two adenocarcinomata and five with invasion of the surrounding muscles, indicating the relatively high frequency of carcinoma in these tumors.

TUMOR OF THE CAROTID BODY

Doctor Hanford presented a man of twenty-six years who applied for treatment in December, 1931, with the history of a swelling in the left side of the neck of four years' duration. He thought it followed a sudden wrench of the neck at water polo. At first he had a vague sense of something wrong. A gradually increasing swelling developed with occasional slight variation in size. He described it as a hard lump. He had no pain, tenderness nor soreness at any time and his general health had been very good throughout. There had never been any sensation of throbbing in the swelling. There was nothing to suggest any focus of infection except large, irregular tonsils with very rare sore throat. The family history and past history were not noteworthy.

He was a well-developed healthy young man with no abnormal findings of consequence except the neck swelling. There was a moderately visible prominence in the upper part of the left side of the neck. There was no visible nor palpable pulsation in the swelling. The skin appeared and felt normal and was freely normal over it. On palpation there was a sense of a deep, firm, non-tender mass of ovoid shape, located where one commonly finds enlarged firm upper deep cervical lymph-nodes mostly beneath the sternomastoid muscle. The outline of the mass was rather easily defined in front and behind but not so the upper and lower poles. It was thought to be somewhat nodular. It was slightly movable but the observation was not made as to whether it, like other carotid body tumors reported, was immovable in a vertical direction. As a diagnosis point, this absence of vertical mobility is not of much value because so many of the firm swellings which might be confused with it are likewise immovable in vertical directions because of adhesions to the carotid sheath and to the muscle.

It measured about five by four centimetres in size. There were a few small lymph-nodes in each posterior neck triangle. A complete blood count and urine were normal.

With a diagnosis of tuberculosis of upper deep cervical lymph-nodes, operation was performed in December, 1931, at the Presbyterian Hospital, New York. There was something unusual in the appearance of the tissue at the start. After isolating the internal jugular vein and retracting it backwards it became apparent that there was a mass deep to the common carotid artery at about its bifurcation and above it. The tumor was surrounded by many blood-vessels, mostly large veins, and a good deal of venous oozing followed the blunt dissection which separated it from the surrounding tissue. The lower part of the tumor was covered by the junction of the common facial-ranine trunk with the internal jugular and below this by the bifurcation of the common carotid artery. The tumor was apparently surrounded by a capsule and at no place was there any suggestion of its invasion of surrounding structures outside of the supposed capsule, but at the upper pole it was attached to the superior constrictor of the pharynx or to the fibrous

tissue around it by a dense cord one-half centimetre in diameter and about one centimetre long. This cord was presumably made up of connective tissue, but had sufficient body to it to make one suspicious of its perhaps containing tumor tissue. The accessory nerve was seen and spared. The hypoglossal nerve ran superficially to the upper part of the tumor and was preserved. The vagus nerve was also isolated and spared. The external carotid artery was divided in order to give better opportunity for the removal of the lower pole of the tumor. At the end of the operation there was a most striking pulsation of the bulb of the common carotid where the external had been ligated. The extreme vascularity with dilated veins and profuse number of veins was explained simply by the pressure of the tumor upon the surrounding vessels. After marking the incision-site on the skin with a streak of methylene blue, well below the level of the nerve to the lower lip, an obliquely horizontal incision was made through skin, platysma and deep fascia. An upper and lower flap were reflected. The sternomastoid muscle was retracted backwards. The internal jugular vein was isolated and retracted backwards. The common facial-ranine trunk was divided between ligatures. The external carotid artery was divided between No. 9 silk ligatures and the tumor then carefully dissected out largely from below upward. The internal carotid artery was retracted backwards. This gave excellent exposure so that the final steps of removal proved easy by sharp and blunt dissection. There was considerable oozing so that a goitre-tube was left in the wound emerging at the anterior angle. Dr. Arthur Purdy Stout, to whom the specimen was submitted for study reported that

> The tumor filled all the criteria of a paraganglioma of the carotid body, in spite of the fact that no chromaffin granules could be demonstrated in the tumor-cells. Menetrier reports that it is rare to find them in paragangliomas from the carotid body although they are frequently found in suprarenal tumors. In 1927, Aperlo and Rossi (Clin. Chir., vol. xxx, p. 26) collected 114 cases of carotid-body tumors, all of which were probably paragangliomas, although called by many other names. Ninety-six were removed at operation. Of these twenty-three died shortly after operation; eight were known to have had reappearances and fifty-nine showed no evidences of return at varying periods after operation. Only three cases have been known to metastasize, the common site being the regional lymph-nodes.
>
> *Diagnosis.*—Paraganglioma of the carotid body.

The patient recovered readily from the operation and has been well up to the present time (March, 1933). He has had no evidence of persistent neoplasm and no paralysis of the hypoglossal nor of the accessory nerve.

The diagnosis before operation in these cases probably will not frequently be made but the early operative findings are often so typical as to lead to immediate diagnosis. The rather high mortality in the past has been due to two main factors, judging from the reports. One is the failure of the operator to define the gross pathology and to extricate the mass in a deliberate anatomical dissection and the other the immediate occlusion of the common or internal carotid artery with its known dangers. If such an occlusion be found necessary, it should be made in two or three stages. Postoperative radiotherapy is not thought necessary where complete removal is thought to have been achieved.

Dr. Charles E. Farr stated that carotid body tumors were extremely rare. According to Rankin and Willbrock (Annals of Surgery, vol. xciii, No. 4, p. 801, April, 1931) only twelve cases had been seen in The Mayo Clinic. Bevan, in 1929 (Surg., Gynec. and Obst., vol. xlix, p. 764), reported

one case and tabled 133 cases from the literature, with 35 per cent. mortality and practically 9 per cent. recurrence. Sullivan, in 1927 (Surg., Gynec. and Obst., vol. xlv, p. 209), reported two cases, Winslow (ANNALS OF SURGERY, vol. lxiv, No. 4, p. 257, September, 1916) reported two cases, and Mix and D'Aunoy-Rigney reported one case in the American Journal of Surgery (vol. xiii, No. 3, p. 529, September, 1931).

Ewing states that the carotid-body tumors usually arise about puberty, increase slowly, growing upon and behind the bifurcation of the carotid. The vessel is often inclosed, compressed or invaded by the tumor.

The diagnostic point, according to Ewing, is that these tumors can be moved laterally but not vertically. They may be present in the pharyngeal wall; they may run up to the skull or downward. Most of them are rounded, lobulated and encapsulated, but rupture of the capsule may occur. They may be firm or soft; may pulsate or give a bruit. They may be vascular or grayish-red or slightly brownish from chromaffin substance in the specific cells. The growth is exceedingly slow, lasting even up to thirty years. Enucleation is usually possible and successful. Local recurrence and local lymph-node involvement are seen occasionally but generalized metastasis is not seen. The microscopic examination is that of alveolar perithelioma.

Doctor Farr described two cases from the surgical service of the New York Hospital, the only ones apparently recognized in the entire history of the hospital. He stated, incidentally, that no case had ever been recognized at St. Mary's Hospital for Children. In the records, according to Bevan, one patient of seven and one of nine years of age have been mentioned.

Doctor Farr's first case was a single girl, twenty-seven years of age, who entered the New York Hospital, June 13, 1923, and was discharged June 21, 1923. The growth was in the right side of the neck and had been present three or four years, with some pain and tenderness for a few months. Excision was performed on the basis of a tuberculous node but a carotid body tumor was diagnosed as soon as the field was exposed. The operation was difficult and bloody. The vessels did not have to be ligated. The tumor was three and a half by two by two and a half centimetres. Recovery was uneventful. She received X-ray treatment and remained well for several years, when she disappeared from view. The microscopic examination showed a perithelioma of low-grade malignancy.

The second case from the New York Hospital service occurred in January, 1933, on the service of Dr. George Heuer, the operation being performed by Doctor Meagher. This was a married woman, forty-nine years of age, who had had a growth in the left side of the neck for about four years. The diagnosis of tuberculous node was made as there was a distinct family history of tuberculosis and a doubtful past history of tuberculosis of the lungs. The husband suffered from paresis. This patient had a Horner's syndrome and a diplopia. The mass in the left neck was approximately twelve by six centimetres. It was not distinctly in the bifurcation of the carotid but rather behind it. It extended upward behind the styloid process of the temporal bone and was so adherent to the base of the skull that complete removal was impossible.

The microscopical picture was that of a perithelioma of the carotid body.

It was essentially of a malignant type and prone to recurrence. This diagnosis was confirmed by Dr. James Ewing. X-ray treatment has been instituted and will be carried out in the endeavor to destroy the remnants of the growth and to prevent recurrence.

Dr. Edward W. Peterson said that he had operated upon a case of carotid body tumor several years ago. The condition was suspected before operation, as there had been a painless tumor for some years, which had increased in size rather rapidly during the previous year. The growth was about the size of an English walnut, and during the operation uncontrollable hæmorrhage from the substance of the gland made necessary the ligation of the common carotid artery. Six hours later there were no evidences of paralysis but ten hours later there was a complete hemiplegia of the opposite side. Cerebral softening followed and the patient died about four months later. The pathological report in this case showed the growth to be highly malignant and rapidly growing.

Doctor Peterson felt that if the carotid body tumor could not be removed without ligation of the internal carotid or the common carotid arteries, that it was better to follow the suggestion of Bevan and treat the case with radium. The majority of the cases show a low degree of malignancy and respond to radiotherapy.

Dr. Franz Torek said he had seen only one case of tumor of the carotid body on which he operated over twelve years ago. It was similar to Doctor Hanford's in that he did not make the diagnosis before operation; his diagnosis had been aneurism because strong pulsation was felt on all sides of the tumor. It differed from Doctor Hanford's in that it was soft. Another difference was that the operation was quite difficult, notwithstanding the fact that the tumor was smaller, being only about one inch in diameter. It seemed it would be necessary to tie off the common carotid artery and the internal carotid, but this was avoided by careful dissection requiring removal of portions of the outer coat of the arteries. The internal jugular vein had to be resected with the tumor. After the operation there was a slight adductor paralysis which lasted three months. The patient is now in perfect condition.

Doctor Hanford, in closing the discussion, said that he was inclined to disagree with Doctor Peterson about leaving in the tumor if the carotid artery had to be ligated for its removal, for he believed that if the tumor could be removed by ligating the carotid artery, it would be better to do this by multiple ligations rather than leave the tumor in. That meant two or three operations but it was perfectly feasible. Most of these tumors are not malignant and one should try to get them out without doing too radical an operation but removing all the tissue that is available.

CALCIFIED CYST OF THE LIVER

Dr. John M. Hanford presented a man, fifty-two years of age, who first came under observation in August, 1928, at the Presbyterian Hospital. He

was a forty-nine-year-old tailor who was born in Italy. He came to the United States at the age of twenty-two. In the preceding April he had developed weakness, loss of weight, a sense of fullness in the upper abdomen, dyspnœa and swelling of the legs. After extraction of the teeth for neuralgia, he became weaker and finally four months after the onset of these symptoms applied for treatment. At this time the important physical findings were the following: Temperature, pulse and blood-pressure were normal. He looked sallow but not jaundiced. The lungs were clear. There was a definite slight bulging to the right, of the lower chest and upper abdomen. The mid-line of the abdomen was slightly convex towards the right. The liver edge was felt two centimetres below the costal margin and besides there was a stony hard mass, apparently a part of the liver, projecting into the epigastrium. There was pitting on pressure of legs and ankles.

The laboratory findings in general were normal. Gastro-intestinal X-ray study was normal except that a large, rounded shadow with a dense thick margin was seen in what corresponded to the middle half of the liver, below the middle of the diaphragm. The X-ray report stated that it had the appearance of a large cyst of the liver, with calcified walls.

At operation, August 15, 1928, the liver presented a large globular hard mass occupying almost the whole of the left lobe and pushing the right lobe downward and to the right. The wall of the extrahepatic part of the mass was stony hard yet resilient enough to make the mass feel cystic. The gall-bladder and ducts were made out normal. Aspiration of the cyst yielded a minute amount of yellowish amorphous material. A scalpel was passed into the cyst along the needle. The opening was enlarged by breaking off some of the calcified wall. The contents consisted of some 500 cubic centimetres of yellowish, green and brown gelatinous semi-solid, amorphous material without odor. This was scooped out with a tablespoon. The large solitary cavity did not collapse after emptying. The interior looked shaggy and appeared to consist largely of fibrous tissue lining the rigid calcified wall. In the upper posterior part of the cavity there was a recess extending upward in front of the right crus of the diaphragm. After irrigating the cavity it was lightly packed with gauze.

Stained sections of the cyst contents showed many leucocytes, about half of which were polymorphonuclear, many fat droplets and cholesterol crystals. Many large, round cells resembling endamœba coli were seen. No hooklets nor scolices were seen. The tissue diagnosis was simply necrosis of the liver. Ordinary cultures of the cyst contents were sterile. Examination of the stools revealed no ova nor parasites.

After the operation the discharge from the cavity became very bile-stained, liquid and profuse. On leaving the hospital four weeks after the operation, the cavity measured 350 cubic centimetres. Scrapings from the lining of the cyst were examined; no protozoa and no cause for the cyst were found.

Six months after the operation, in February, 1929, the discharge was less profuse, more yellow and more mucoid. The more he ate and drank the more discharge appeared. X-ray showed the cavity slightly smaller. Much hard calcium was felt within the cavity by means of a probe. A year after the operation he felt generally well but not able to work. He continued to use a tube drain which he changed twice a day. The amount of discharge was about 120 cubic centimetres in twenty-four hours. The cavity measured about thirty cubic centimetres.

In March, 1930, some twenty months after operation, the discharge persisted in small amounts; the cavity measured about twenty-five cubic centimetres; the depth of the calcium-lined track (or liver fistula) measured twelve

centimetres; and X-rays showed decrease in the size of the calcium shadow. It was thought that spontaneous closure of the track was unlikely because of the dense plaques of calcium lodged in its wall. He was then re-admitted for further study as to treatment. The great need appeared to be removal of calcium so that the track might heal by granulation. His chief complaint then was pain in the right trapezius region. Installations into the cavity of acetic-acid solution, a 7 per cent. solution, were instituted. The washings were found to contain calcium, and the calcium in the track felt softer after three weeks of this treatment. The acetic-acid treatment was continued for a time, although it caused great increase of the right suprascapular pain.

Two years after the operation the patient returned for the first time with a smile and saying he was better. The discharge was only about thirty-five cubic centimetres a day; the opening in the abdominal wall was small, admitting a small rubber tube; much calcium was still felt within.

Two and one-half years after the operation, when the biliary mucoid discharge had reached a still smaller amount, he noticed that occasionally, on rising, he spat up a little bitter yellow fluid just like that in the discharge. This condition continued several months until about three years after the operation when, one day, he came to the hospital in great distress due to coughing and raising much yellow, bitter sputum. He was asthenic and had a very low blood-pressure. He was re-admitted for study. Chest X-rays showed evidence of infiltration around the right lower bronchus and its ramifications just above the right half of the diaphragm. Methylene blue injected into the abdominal sinus was coughed up in the sputum on the following day. Bronchoscopy revealed distinct redness of the bronchial mucosa in the right lower lobe. Lipiodol instilled into the right lower lobe was demonstrated in the liver cavity by X-ray, five days later. There appeared to be adequate evidence therefore, to establish the diagnosis of a hepatopulmonary fistula which had formed after the cyst contents found almost complete obstruction at the abdominal outlet.

The therapeutic indications were to reëstablish free drainage through the abdomen and to remove calcium with the hope of subsequent granulation and healing of the liver cavity. The fear of hæmorrhage deterred from attempting excision.

October 16, 1931, three and a quarter years after the first operation, the second operation was made. This consisted of excision of the fistula opening, of partial excision of the liver opening, of the removal of all accessible, safely removable calcium plaques, and finally, of the application of the high-frequency coagulating current to all remaining plaques with the purpose of inducing necrosis in their soft-part beds, and their ultimate separation and removal. The hope of healing rested on the presence of granulation tissue seen between the plaques.

The day following operation, subcutaneous emphysema was quite marked in both sides of the lower part of the neck, most marked in the left supraclavicular region. Air is thought to have entered the mediastinum from the abdominal wound, through the diaphragm, and thence up to the neck. By the sixth day after operation, the emphysema and the bile in the sputum had disappeared; the cyst cavity measured twenty-five cubic centimetres, and he felt improved. During succeeding days numerous pieces of calcium were removed from the wound which daily received a pack of 50 per cent. silver nitrate solution, designed to cause sloughing away of the plaques. This caused sloughing of soft tissue and of plaques both. Five weeks after operation the track was puddled frequently every day with 2 per cent. lactic-acid solution with the idea of removing the calcium or calcium lactate. At this

time the track contained but ten cubic centimetres of fluid and much of the calcium had come away. During the lactic-acid treatment, washings from the track after puddling for twenty minutes revealed about five milligrams of calcium per 100 cubic centimetres of fluid. Doctor Bauman suggested the treatment and made the chemical study.

The patient finally left the hospital in December, 1931, greatly improved; and one month later, three and a half years after the first operation, the abdominal fistula healed to remain healed up to the present time (March, 1933). He steadily improved and has continued to feel well, except for occasional minor symptoms, and he has been working.

It is doubtful if this lesion should be classed as a cyst of the liver. It is evidently neither an amœbic abscess nor an echinococcus cyst. Almost all solitary cysts of the liver (which are rare) are epithelial-lined and are more common in females. It appears to be rather a degenerated, non-malignant neoplasm. The most probable explanation is that this lesion was first an adenoma or cysto-adenoma of the liver, which, because of its fibrous and calcareous boundary, degenerated from loss of blood supply into an amorphous mass. Increase of size causing symptoms may well have resulted from the gradual accumulation of bile seeping into it from uncalcified crevices in its wall.

REPEATED REPAIRS OF LARGE INCISIONAL HERNIA

Dr. Kirby Dwight presented a man who, at the age of fifty-three years, came to Roosevelt Hospital in May, 1928, with a large incisional hernia. Twenty years before he had been operated upon for a ruptured appendix and the wound had been drained. There had been severe infection of the wound and some slough of fascia.

Ten years before the patient had noticed a swelling in the region of the scar. This gradually increased in size and he began to wear a support. Six months before admission the skin had begun to ulcerate at the point of maximum pressure of the support. This ulcer had remained open and had gradually increased in size. The man was quite obese, but husky and strong, with good abdominal muscles. The hernial sac was very large and contained coils of intestines which could be discerned just under the skin. The defect in the abdominal wall was also large, measuring about twelve centimetres by fifteen centimetres with the long axis extending obliquely from above downward and inward.

This hernia seemed inoperable on account of its size. It didn't seem possible to get that mass of intestines back into the abdominal cavity and then be able to get a decent closure of the defect. And then there was the ulcer. Infection from it would certainly complicate any attempt at repair. But if he kept on wearing a support it was only a matter of time before the ulcer would go through into the coil of small intestine that was adherent just beneath it.

So he was kept in bed for six weeks on a low-calorie diet until the ulcer had healed and he had lost a few pounds in weight; and then he was operated upon.

At operation a wide area of normal skin was excised with the scar of the ulcer in the attempt to avoid contact with the pyogenic organisms that would still be in the scar tissue. It was necessary to dissect very close to the under surface of the scar when separating it from the adherent loop of intestine.

The sac was found to contain the cæcum and omentum as well as a great deal of the ileum, all more or less adherent to the wall of the sac.

The omentum was resected and the cæcum and small intestine were reduced, but it was only with the greatest difficulty that the small intestine could be gotten back into the abdominal cavity and kept there while the repair was made. It was subjected to a good deal of pushing and handling. The wall of the sac was so thin and frayed out that it could not be utilized in the repair, and the edges of the defect itself had to be approximated. They could not be overlapped and it was only with great difficulty that they could be brought edge to edge. They were sutured together with strips of fascia lata from the left thigh.

A day or so after the operation the patient began to show symptoms of ileus, vomiting and great distention; medical treatment not proving effective a medium jejunostomy was done on the sixth day, using the Witzel method. This functioned freely and the vomiting and distention were relieved. Also by this time the hernial wound had become frankly infected and the skin edges had to be separated for drainage. The fascial sutures became necrotic but held sufficiently to prevent a disruption of the wound. In this they were greatly helped by the partial collapse of the intestines following the enterostomy and by a rapid loss of weight due to the same cause.

The jejunostomy stopped draining in about two weeks, the hernial wound healed and the patient was discharged with the repair apparently firm.

A year later, in July, 1929, he returned to the hospital with a recurrence of the hernia. The defect in the abdominal wall was the same as on his previous admission, twelve centimetres by fifteen centimetres, but the sac was shallow, more of a bulge than a real sac, and there was no ulcer. He had dieted and lost weight so that the abdominal wall was quite lax.

At the second attempt at repair the edges of the defect were overlapped for about one and a half centimetres, using heavy chromic gut. Then with strips of fascia lata from the right thigh this seam was overlaid with a lace-work continuous suture.

This repair has remained firm throughout most of its length, but about a year after the second operation two small recurrences appeared or were noticed, one at the lower angle and one at the upper angle.

The third operation was done in June, 1932. The two recurrences, each about three centimetres in diameter, were repaired by overlapping the edges, again using fascia lata from the right thigh. It is only nine months since this last operation and it is too early to promise a cure, but the main part of the defect has been closed.

DR. SEWARD ERDMAN said that these large incisional hernias were often very difficult to cure, a recent report from The Mayo Clinic recording 23 per cent. recurrences, and other reports running as high as 30 to 40 per cent. are encountered in medical literature. He has found that it will sometimes be necessary to resect a large part of the omentum in order to reduce the hernia into the abdominal cavity. The use of an enterostomy in Doctor Dwight's case as a means of combating undue post-operative distention was an excellent measure. Doctor Erdman has recommended the performance of enterostomy in cases where distention increased the hazard of hernia operation, especially in cases of marked strangulation of a hernia, where there is the least doubt of viability of the returned bowel, or where the

returned loop seems liable to remain paralyzed for some time, with resulting dangerous distention.

Dr. Carl G. Burdick said that as regards enterostomy in these large hernæ, if pitressin is used more the indications for enterostomy will be less.

An ampule should be given before the abdominal wound is closed and a second ampule before the patient leaves the operating room. An ampule is given every four hours for the first twenty-four and then can be reduced to every six or eight hours for the next day or two depending on conditions.

If it is not possible to get an overlapping of the muscle flaps or if they can only be approximated under considerable tension, it is well to reinforce the suture line with a fascial graft. Formerly they were sutured with chromic gut and the union with the muscle was only by connective tissue. Recently the speaker has been using a continuous fascial suture to anchor the graft which overcomes this objection.

LUDWIG'S ANGINA

Dr. Herbert Willy Meyer presented a man thirty-five years of age who was admitted to the Surgical Service of Dr. Carl Eggers at the Lenox Hill Hospital suffering from a sore mouth, swelling of the neck on both sides, inability to talk, move the tongue, or swallow and some difficulty in breathing. He had suffered from poor teeth and sore gums which undoubtedly were the primary focus of infection. Five days before admission he had noticed a swelling under the jaw and in his mouth and had pain in the tongue. Fever was slight. The following day he had higher fever and chilly feeling. Intense pain on swallowing developed and two days before admission he was unable to speak or open the mouth. He had high fever for forty-eight hours before admission which at time of operation was 104.6°.

Examination showed intense œdema and swelling of the floor of the mouth with a rigid tongue. Both submaxillary regions were swollen but the skin was movable over the swelling. There was diffuse cellulitis of the submaxillary regions and the floor of the mouth. The blood count was 12,500 white blood-cells with 71 per cent. polymorphonuclear leucocytes. Smears from the gums showed the presence of Vincent's angina and culture gave a mixed group of organisms.

Immediately upon admission the patient was operated upon under local infiltration anæsthesia. Two incisions were made in either submaxillary region parallel to the lower border of the mandible about two inches in length with an electric-cautery knife. The skin and platysma were incised and the submaxillary space entered. No pus was encountered but marked œdema. The finger was introduced into the submaxillary fossa and passed between the mucous membrane and the mylohyoid muscle from one side to the other. No free pus encountered. The space passing backward towards the neck and the angle of the jaw was also opened with the finger and drainage was instituted by split rubber drains from one submaxillary fossa to the opposite one and tampons placed into the space passing backward and between the floor of the mouth and the mucous membrane. Thus the entire phlegmonous area of the submaxillary region and the sublingual region was widely opened and drained. No pus was encountered but intense œdema.

There was profuse serous discharge from the wound during the first twelve hours. The sepsis was overcome by hypodermoclyses and fluids per

rectum. The œdema rapidly subsided in the floor of the mouth. The second day the wounds began to discharge foul-smelling pus and to look gangrenous and black. Two intravenous injections of neoarsphenamine were given on account of the Vincent's spirillum infection in the mouth. On the second day after the operation ten cubic centimetres of streptococcus erysipelatous vaccine were given. During the next few days the discharge from the wounds was still profuse and gangrenous fascia was discharged in large amount. A spontaneous perforation into the mouth occurred on the second day but it was impossible to locate this on account of the swelling and inability of opening the mouth.

Thereafter the patient made an uneventful recovery and was discharged from the hospital on the twelfth day post-operative with clean granulating wounds which took about two more weeks to completely heal.

Ludwig's angina must be looked upon as a morbid entity. It was described by Ludwig in 1836 for the first time and his description has been confirmed by other writers. Delorme considered that it was primarily a phlegmon of the sublingual region but this is undoubtedly incorrect as the disease begins as a submaxillary cellulitis that spreads to the floor of the mouth and to the sublingual regions secondarily.

One of the best original articles presented on this subject was published in the forty-seventh volume of the ANNALS OF SURGERY on p. 161, written by Dr. T. Turner Thomas, of Philadelphia. This is well worth studying if one is interested in this disease.

The frightful rapidity and certainty with which an unchecked case proceeds to a fatal termination should be warning enough for an early recognition of the disease and early radical and extensive incision and drainage even before the development of free pus. The dissection of the cellulitis and the inflammatory processes is backward, in fact it is the only direction in which the rapidly accumulating new inflammatory material can force its way and leads to early œdema of the larynx, which is the main reason for the high mortality.

The primary focus may be an insignificant one in the mouth as a carious tooth, or it may be tonsillitis or an ulcer in the mouth. By lymphatic drainage the infection travels towards the lymph-nodes within the capsule of the submaxillary salivary gland. Here it is held for a short time and if the infection spreads by contiguity through the capsule of the gland it develops into a cellulitis of the submaxillary space. Any organism may cause the infection. It may be the streptococcus alone, or a mixed infection of other organisms as the staphylococcus, pneumococcus or the bacillus of malignant œdema. The infection or submaxillary cellulitis spreads along the opening in the muscular buccopharyngeal wall through which the submaxillary salivary gland projects into the floor of the mouth. The submaxillary cellulitis thus becomes a sublingual cellulitis. This is the sublingual phlegmon of Delorme. The mouth and pharynx are thus invaded by the submaxillary infection.

The only direction in which the cellulitis of the floor of the mouth can spread is backward. The rigid indurated tongue is pushed upward against the hard palate. The gums and the teeth prevent extension outward and the floor of the infected area is formed by the mylohyoid muscle. Hemmed in on all sides except posteriorly the infection and œdema rapidly spread backward and downward to the larynx which is only two to two and a half inches distant from the main inflammatory focus. Dysphagia and dyspnœa are early symptoms and death results from invasion of the larynx in most cases accompanied by the septic intoxication. It is these alarming symptoms which are characteristic of advancing Ludwig's angina.

The only proper treatment is early recognition and heroic incision into and drainage of the focus from which the œdema is spreading. Local anæsthesia is essential as any general anæsthesia will only increase the difficulty in breathing and swallowing. The median suprahyoid is the safest incision but not the best one in these cases. A wide submaxillary incision on both sides parallel to the lower border of the mandible and wide opening of the submaxillary space and the sublingual space will give best drainage of these areas. If need be the mylohyoid muscle can be incised. It is essential to drain the space between the mucous membrane of the floor of the mouth and the mylohyoid muscle so that drainage can be instituted from side to side through this entire area permitting all of the œdema to drain to the surface. Incision through the mouth is usually not feasible and also not necessary.

Dr. Henry W. Cave considered this a classical case of Ludwig's angina. He commented on the fact that the mortality in these cases is very high and on the fact that in this case particularly immediate incision and drainage decided the outcome. It is of some interest to know that the first case of classical Ludwig's angina, from which Ludwig wrote his vivid description, recovered without the aid of surgery. Six leeches, small poultices and the spirits of Mendererus effected a cure.

The records of the Roosevelt Hospital show that between the years of 1910–1933 eleven typical cases of Ludwig's angina were treated, eight males and three females, the average age being twenty-eight years. They entered the hospital with a history of symptoms lasting from three to seven days. All complained of swollen necks, difficulty in swallowing and elevation of temperature. Pus was found in six cases. It was necessary to do tracheotomy in two cases and secondary operations were performed in two cases. In these eleven cases there were two deaths, one from an embolus on the fourth day post-operative, the other eight hours after operation, the patient having collapsed on the table and tracheotomy having been resorted to. The course in this condition is described vividly in Ludwig's original article which appeared in the Medicinische-Correspondenzblat of Wurtemberg Artztlichen Verein, published in Stuttgart in 1836. There is an excellent digest of Ludwig's original article in the Gazette Medicale of Paris, 1836.

CARCINOMA OF THE LARYNX

DR. HERBERT WILLY MEYER remarked that the lymphatic drainage area of the larynx differs from that of the lips and mouth and cheek in that the submental and submaxillary lymph-node groups are not involved. This means that only the anterior chain up to the level of the digastric muscle belongs to the cancer field, but this field does include the posterior deep chain if the anterior chain is involved and in advanced cases the supraclavicular lymph-nodes are also involved. There is one lymph-vessel trunk that passes down and directly enters the supraclavicular region without involving the anterior or posterior deep chain. About one year ago he saw a case who developed a metastasis just above the clavicle following a carcinoma of the larynx, without any involvement in the neck.

The main methods of treatment for larynx carcinoma are radiation and surgery and it seems that the best results can be obtained by surgery. With small intrinsic tumors a laryngo-fissure may be done with the removal of the tumor but in the great majority of cases a laryngectomy is indicated and if there is any extrinsic involvement of the larynx a bilateral lymph-node dissection should be added, removing the larynx together with the lymph-nodes of both sides. On the involved side the lymph-node dissection should include the posterior deep chain, while on the opposite side it is necessary only to remove the anterior chain. He has had two cases in the past years who have remained well for over four years following laryngectomy. In one there was a bilateral lymph-node dissection added while in the other case this was omitted as the patient was almost *in extremis* before the operation. The latter case's condition was so bad that it was decided to perform the operation under spinal anæsthesia. One hundred and fifty milligrams of neocaine were injected into the first lumbar spinal interspace and it was possible to remove the larynx without pain.

He presented a woman, fifty years of age, who was admitted to the New York Skin and Cancer Hospital on the service of Dr. Girard F. Oberrender of the Nose and Throat Service in June, 1928. The patient stated that she could only speak with a whisper for the past four years following an operation for a rupture. A direct laryngoscopy was performed in June. A benign lesion was diagnosed. September 26, 1928, a biopsy was taken. This time a cauliflower-like growth could be seen below the one vocal cord on the right side and the diagnosis of inflammatory changes was made. Dr. George Semken was called in consultation and a radical operation was decided upon. On October 10, 1928, under colonic ether oil anæsthesia a laryngo-fissure was first performed and a cauliflower growth found below the right vocal cord. A frozen section was taken and reported malignant. Hereupon a typical laryngectomy was performed removing the bilateral cervical lymph-nodes together with the larynx from the posterior belly of the digastric down to the omohyoid crossing. The trachea was sutured into a separate suprasternal incision according to the technic of Gluck. The larynx was removed from below upward separating it from the œsophagus and opening into the pharynx at the level of the greater cornu of the hyoid. The pharynx was sutured by two rows of sutures and the skin closed with interrupted silk. At the time of the operation while the pharynx was open an Einhorn duodenal tube was

introduced so that the patient could be fed immediately following the operation. The pathological report was a prickle-cell epithelioma of the larynx, Grade A, with hyperplasia of the lymph-nodes.

The patient made an uneventful recovery and has remained perfectly well up to the present time.

This patient was presented to show that if surgery is contemplated that a laryngectomy with bilateral lymph-node dissection will eliminate the entire cancer field at one time. The stump of the trachea sutured into the separate suprasternal incision makes a nice tracheotomy and the use of the Einhorn duodenal tube introduced at the time of the operation helps greatly in the convalescence of the patient and in wound healing.

Dr. Franz Torek said that the fact brought out in this presentation that with small intrinsic tumors a laryngo-fissure may be done with the removal of the tumor, but in extrinsic involvement laryngectomy and bilateral lymph-node dissection should be performed, recalled a unique case he had seen last year. In this case, besides involvement of larynx and both sides of the epiglottis, the carcinoma had extended to the back of the tongue. In primary carcinoma of the posterior part of the tongue the indication is to remove the whole tongue, but here the involvement of the tongue was only by superficial extension from the epiglottis, so it was considered justifiable to resect only the affected portion. Excision of the larynx was performed working from below upward. When everything was freed to the hyoid bone the liberated larynx was drawn forward and turned in a direction toward the chin till the posterior portion of the tongue appeared in the wound. It was decided to remove the affected part of the tongue in continuity with the larynx by cautery excision. To accomplish this a suture, directed transversely, was placed in the tongue anterior to the affected area. Traction on this suture brought the tongue into the wound well enough to insert a second suture anterior to the first. The sutures were not tied but simply held so that the cautery knife could be used between the two. Their additional object was to control bleeding, as no preliminary ligation had been done. Fine silver wire was employed to guard against accidental cutting of the sutures by the cautery knife. It was surprising how little hæmorrhage there was in cutting through the tongue. It seems that the part of the tongue immediately in front of the epiglottis is much less vascular than the middle and anterior portions. The physician in charge of the after-treatment used a suction apparatus, the end of which consisted of a spiral wire covered with thin rubber, thus affording a maximum lumen relative to the total diameter of the tube. This was introduced into the trachea off and on to suck out the mucus, and it worked very well. But one day, on removing the suction tube, the wire portion tore off and was found by X-ray to be well down in bronchus. The literature shows that occasionally foreign bodies can remain in the bronchi for a long time without harm so it was decided to leave it there until the wound had completely healed. But over night the patient got up a sudden œdema of the lungs and the next morning was dead, proving that leaving in a foreign body is dangerous practice.

CARCINOMA OF THE PENIS

Doctor Meyer presented a man of over fifty who was admitted to the New York Skin and Cancer Hospital in January, 1929, suffering from a large ulcerating epithelioma of the entire glans penis and a portion of the

shaft. The tumor was about the size of a lemon and the inguinal lymph-nodes were involved on both sides. January 7, 1929, under colonic ether oil anæsthesia, the penis and the skin about its base and the femoral and inguinal lymph-nodes were removed in one mass. The pathological report showed a prickle-cell epithelioma Grade B with hyperplasia of the lymph-nodes. The urethra was sutured into the base of the scrotum. The patient made an uneventful recovery. He has been taught to use a urethral sound so as to be sure that no stricture will form at the outer end of the urethra and up to the present time, which is now over four years, he has been entirely well and free from all symptoms.

The patient was shown in order to make a plea for an opportunity of performing a series of such cases so that a comparison can be made between such radical surgery, less radical surgery and the end-results obtained by radium and X-ray. Also to show the comfort that a patient can live in if the urethra is sutured into the base of the scrotum instead of into the perineum, which necessitates sitting down when voiding instead of standing up as this patient can do. The very same principles used in this case in the male can be used when operating upon cancer of the external female genitalia.

Doctor Meyer further remarked that there are two schools as to the best treatment of cancer of the penis. Perhaps the majority favor X-ray and radium treatment as this method preserves the organ. The minority is composed of those surgeons who favor radical surgery. At the present time the greater number of cases come into the hands of the radium men while only a few cases come for radical cancer surgery. Therefore it is difficult to compare the two methods and determine which is the better of the two. It would be fine if in some institution the cases would be divided and half would be treated by radium and the other half by cancer surgery. These surgical cases should all be treated and operated upon by a standardized technic so that the results and statistics would be of some value. Statistics are of little value from a certain institution if different methods of surgery are employed. Cancer surgery eventually will be standardized and this will depend upon a careful study of the primary lesion and the lymphatic drainage area. This shows that the lymphatics pass along the dorsal portion of the penis and then pass along the skin to the femoral and inguinal lymph-nodes. One lymph vessel passes into the inguinal canal and enters the lymph-node that lies just within the external ring. From here the drainage enters the lymph-nodes along the external and later common iliac veins. Technically, it is possible to remove the penis and the skin about its base and the inguinal and femoral lymph-nodes all in one piece crossing the cancer field only at that point where the lymph vessels pass into the abdomen. Closure is good and if a stump of the urethra is left this can be sutured into the base of the scrotum so that the patient can urinate standing up, which is a great advantage over the perineal urethra. It is not necessary or indicated to remove the testes or the scrotum in any case unless the scrotum is involved in the primary malignant lesion.

DR. FRANK E. ADAIR said that carcinoma of the penis is a disease possessing a high mortality. At the Memorial Hospital the cases are handled along a little different line than in most institutions. In other clinics the usual practice is that of a radical amputation of the penis which operation also includes both groin node basins all in one big block dissection. This operation has a considerable mortality. At the Memorial Hospital the primary lesion is treated either by amputation or irradiation, depending on the exact extent and the amount of infiltration of the tumor; and a waiting attitude is assumed as to the treatment of the groin nodes. On account of the fact that an epithelioma of the penis is nearly always ulcerated, the clinician is uncertain (unless it happens to be an advanced case) as to whether he is dealing with inguinal nodes that are infected or cancerous. This point is determined by an amputation of the penis two centimetres proximal to the lesion. We then wait to watch the change that will occur in the nodes. If the groin nodes are those of infection they will resolve and disappear; if cancerous, the hard nodes remain. If the primary lesion is small (under two centimetres in diameter) and superficial, the most ideal form of treatment is that of the application of a radium placque for 1,200 millicurie hours at a distance of one centimetre. This method of treatment is most satisfactory and gives a very high percentage of cures. Dean (Am. Jour. of Surg., vol. v, No. 1, p. 32, July, 1928) reported thirteen such cases from the Memorial Hospital. By this method of treatment twelve of the thirteen cases (92 per cent.) were alive, well and free of disease. On the other hand, if the tumor is large and has penetrated Buck's fascia involving the cavernous tissue, the groin nodes are usually involved. The problem is then chiefly surgical. In this latter group the penis is amputated two centimetres proximal to the epithelioma. Incidentally, one does not get local recurrence following such an amputation. Later the groin nodes are then attacked by one of two methods: (1) A careful groin dissection on both sides. (2) By the introduction of gold seeds containing radon of 1.5 millicuries each, into this node-bearing area. This area is then subsequently treated by radium packs or high-voltage X-ray.

Squamous-cell epithelioma, unlike basal-cell, is usually resistant to irradiation. There are, however, those Grade III and Grade IV types which are very radiosensitive; but they are rare. Too frequently, these cases go for a considerable period without a biopsy, being treated for chancre. Much valuable time is thereby lost, while the therapy becomes more difficult and the end-results poorer. The tight prepuce with its underlying irritating desiccated smegma is believed to be the basis of this disease. We have never seen an instance where epithelioma of the penis developed in a case circumcised during infancy. This fact accounts for the complete lack of this disease in the Jews and Mohammedans.

PERFORATION OF THE JEJUNUM

DR. JOHN C. A. GERSTER presented a man, forty-four years of age, who was admitted to Doctor Stetten's service, Lenox Hill Hospital, February 16,

1933. Six hours previous to his admission, he experienced severe epigastric pain, while lifting a heavy object. A hypodermic of morphine did not afford relief. He came to the hospital, making his own diagnosis of perforated gastric ulcer, because the present symptoms were identical with those he had experienced two and a half years previously, when he was operated on at St. John's Hospital, Long Island City, for perforation of a duodenal ulcer.

He was in good general condition. Locally, there was a firmly healed right epigastric scar on the abdomen, about four inches long. There was board-like rigidity of the abdomen.

He was operated on within an hour of admission. Upon opening the peritoneum, gas and considerable bile-stained, turbid, free fluid escaped. Many post-operative adhesions of omentum, stomach, gall-bladder, duodenum and liver were freed. The first and second portions of the stomach were found moderately filled with gas. Entire anterior aspect of stomach from cardia to pylorus minutely inspected; duodenum likewise; no perforation to be seen. Omentum and transvere colon then freed from their adhesion to anterior abdominal wall, over to right lumbar gutter. Upon turning up omentum and transverse colon, much more bile-stained, turbid, free fluid was aspirated from both lumbar gutters as well as pelvis. Moderate amount of fibrin found in all four quadrants of the abdomen, causing many adhesions. The appendix appeared normal.

Inspection of the jejunum, beginning at the duodenojejunal flexure, revealed a small perforation on the anterior wall of the jejunum, about one-half centimetre in diameter from which bubbles were escaping. This perforation was directly opposite the more distal end of a posterior suture gastroenterostomy, and midway between upper and lower borders of the jejunum. Perforation closed with one fine silk mattress suture reinforced by a second inverting suture. Transverse colon and omentum replaced in normal position; wound closed in layers.

The patient has made an uneventful convalescence. Subsequent correspondence with St. John's Hospital revealed that his previous perforation was in the first portion of duodenum and that prior to perforation there was a long ulcer history.

The case is presented because of the comparative rarity of acute perforation of the jejunum.

Dr. DeWitt Stetten felt that this case was of great interest from two standpoints. The first was the extreme rarity of perforated jejunal ulcer. Doctor Stetten has seen a considerable number of jejunal and marginal ulcers after gastroenterostomy, but never before has he encountered a free perforation of this variety of ulcer. In fact, he has never heard of a case that has been published in the literature. These ulcers may become penetrating, but, owing to the peritoneal adhesions at the site of the gastroenterostomy, perforation is highly improbable. The second point of interest is the etiological factor of the perforation, particularly important to the patient from the standpoint of compensation insurance. In this case there seems to be no doubt that the perforation was the direct result of strain, as it occurred immediately after the patient lifted a heavy radiator, and it should be regarded as a compensable accident. It can be readily understood that a sudden violent contraction of the abdominal muscles can increase the intra-abdominal pressure and can squeeze the jejunum against the spine and thus rupture a weakened ulcerated area. Had it not been for this unusual strain the ulcer

may have become covered with fibrin and adhesions and a free perforation may never have occurred. Last year Doctor Stetten was consulted in a case of rupture of the ileum from indirect violence. A man had fallen rather heavily on his ischium and shortly after the fall developed acute abdominal symptoms. He was taken to a hospital where, after a short period of observation, an abdominal operation was performed. A ruptured ileum was found and repaired, but the patient succumbed. Doctor Stetten was asked whether this type of indirect violence was a competent cause for the rupture of the intestine and he gave his opinion in the affirmative. He felt that the intense contraction of the abdominal muscles could cause the rupture almost as readily as the better recognized and commoner cause—namely, severe blunt force to the abdomen, such as a horse's kick or a crush from an automobile accident. Other observers have substantiated this view, and, if a normal ileum can be ruptured by the contraction of the abdominal muscles, certainly an ulcerated intestine can also be caused to perforate.

EPITHELIOMA OF THE LIP WITH PARTICULAR REFERENCE TO LYMPH-NODE METASTASES

Dr. Robert H. Kennedy read a paper with the above title for which see page 81, and presented five patients to show cosmetic and functional results after block dissection of the cervical lymph-nodes. All were operated on at the Stuyvesant Square Hospital.

Dr. Carl Eggers called attention to two important points:

(1) The seriousness of epithelioma of the lip which is so often considered a rather harmless lesion, and

(2) The importance of treating this particular growth the way other cancerous lesions are treated, namely, by the excision or destruction of the local growth, and the removal of the lymphatic drainage area of that region.

With the advent of the Röntgen-ray and radium in the treatment of malignant tumors, a certain amount of confusion has resulted. It is known that radium is most effective in lesions of the mouth, skin, and uterus. It is on the primary lesion in all these localities that the good results are noted, not on the metastatic lymph-nodes, for it is generally admitted that adult type epidermoid carcinoma is very radioresistant.

In considering the treatment of malignant mouth lesions, of which epithelioma of the lip is one, two schools of thought have developed. One, in a general way, is represented by the radiologists, the other by the surgeons. It is not so much on the treatment of the primary lesion that they differ, for the views of the surgeons on the treatment of the primary lesion have always been liberal, they have admitted, and do admit today, that not only excision of the lip lesion with the knife will cure it, but that it may be cured by excision with the electrocautery knife, or that it may be cured by destruction with the cautery, electrocoagulation, radium, Röntgen-ray, or other methods. It is on the treatment of the lymphatic drainage area that there is considerable difference of opinion. The surgeons feel that no consideration of the treat-

ment of an epithelioma of the lip is complete which does not include the lymphatic drainage area, for it is known that the primary tumor frequently remains localized for only a short time, and that there is great tendency for cancer-cells to spread into the lymph-nodes draining that area. This tendency, as a rule, is greater in the small infiltrating ulcerating growth than in the papillary variety. How should this invasion be met?

In a general way it may be said that radiologists are guided by the thought that prophylactic external radiation over the neck by means of the Röntgen-ray or the radium pack in the grossly uninvolved cases is sufficient. It is their view that in the great majority of cases no neck metastases will develop if the primary tumor has been cured by radium. They do not expect a cure of lymph-nodes already involved, but believe that irradiation stimulates the normal resisting power of lymph-nodes to carcinomatous invasion. In case the lymph-nodes are grossly involved, or subsequently become involved, they are either excised in a surgical manner by block dissection, or they are treated with interstitial irradiation by the implantation of radium into the wound.

Surgeons, on the other hand, follow the reasoning that it is not possible to tell by external palpation whether invasion of lymph-nodes has taken place, and that small cell nests may be present very early. They are guided by the experience of years, which has shown that if a cancer has invaded the neck, the outlook for permanent cure is bad. They therefore practice routine block dissection of the neck in the majority of cases, before there is any clinical evidence that the lymph-nodes have become involved.

Our knowledge concerning the nature of malignant growths, their spread and their successful treatment, has been gradually acquired. There was a time when only the local lesion was excised, and it was because of the many poor results that surgeons began to remove involved lymph-nodes. Later on, stimulated largely by the studies of the lymphatic system by Kuettner and others, surgeons went a step farther and removed the nodes before there was any clinical evidence that they had become invaded. This practice is still being followed by the majority of surgeons, and on the basis of Doctor Kennedy's report it appears that it will be wise to continue it. He reports that among ninety-eight patients operated on in whom cervical lymph-nodes were palpable before operation, malignant involvement was found in thirty-two, or 33 per cent. This illustrates that the mere presence of enlarged nodes gives no definite evidence whether they are involved. Still more interesting is the finding of involved lymph-nodes in nine patients, or 14 per cent. of a group of sixty-four patients in whom no lymph-nodes were palpable before operation.

As in all other surgical conditions, we must use judgment regarding the indication for, and the extent of, an operation. We know that lip lesions vary a great deal in malignancy, and that the papillary variety is less apt to metastasize than the infiltrating ulcerating variety. It may, therefore, be perfectly safe to be satisfied with a simple excision or destruction of the lesion in the former group, especially if it is possible to have a careful follow-up. In Doctor Kennedy's series of 246 cases fifty did not have a neck

dissection done. In the majority of patients, however, one offers them a better chance of life if the regional lymph-nodes are removed together with the primary lesion.

Dr. John M. Hanford said that there was accumulating evidence that some of these lip epitheliomas were in a class by themselves. Some are small and do not invade the muscle and microscopically indicate low grade of malignancy and have no palpable lymph-nodes. It is rare to see extensive surgery for basal-cell epitheliomas because these so rarely metastasize to lymph-nodes. Likewise there is a certain type of lip epithelioma that so rarely metastasizes to the lymph-nodes as to make radical surgery equally contra-indicated. The work of Ragaud at the Radium Institute of Paris and the experience at the Huntington Memorial Hospital in Boston have established a certain group of lip cancers which appear to be best treated by radium for the lip and by no treatment of any kind for the neck. A critical analysis of these cases is very important.

STATED MEETING HELD AT THE NEW YORK HOSPITAL MARCH 22, 1933

The formal session was preceded by a series of operations in the amphitheatre of the New York Hospital by the following members of the surgical staff of that hospital: Heuer, *Thoracotomy for Intrathoracic Tumor;* Pool, *Laparotomy for Diverticulum of the Jejunum;* Andrus, *Gastroenterostomy for Duodenal Ulcer;* Farr, *Subtotal Thyroidectomy for Goitre;* Dineen, *Laparotomy for Gastric Ulcer;* Erdman, *Hernioplasty for Ventral Hernia;* Bowers, *Cholecystectomy for Cholelithiasis;* Meagher, *Subtotal Thyroidectomy for Goitre.*

The following short papers from the Surgical Research Laboratory of the Hospital were read:

A POSSIBLE RÔLE OF THE TOXIC FACTOR IN INTESTINAL OBSTRUCTION

By Wm. DeW. Andrus, M.D., and George M. Guest, M.D.
of New York, N. Y.

From the enormous mass of work which has been done on intestinal obstruction the fact that death in high obstruction may be due to the action of one or both of two lethal factors may be considered as fairly well established. The first of these is a severe derangement of the normal acid-base equilibrium of the body, brought about by the fact that fluid containing chloride—and to a lesser extent base secreted in the stomach and duodenum —is lost to the bodily economy through being vomited, or through being prevented, because of the obstruction, from reaching that part of the intestine where it would normally be reabsorbed. The second factor is a toxæmia, and while the source, mode of absorption and exact nature of this toxic factor are still the subject of some difference of opinion, its existence in most cases is generally recognized.

In simple midduodenal obstruction in dogs it seems that it is possible

to produce a condition in which the acid-base derangement plays the chief and indeed perhaps the only rôle. Either that is the case or the administration of NaCl neutralizes the toxic factor in this instance. Despite the prominence assigned to this last idea, *i.e.*, the neutralization of the toxin by NaCl—by Haden and Orr, the evidence for it is meagre at best, since NaCl will not neutralize the toxin in vitro, nor will the administration of NaCl prevent death when the toxin is injected intravenously.

In patients, however, the additional factor of strangulation, adhesions, *etc.*, with toxæmia is apparently added in most of the cases, and the administration of NaCl alone, while beneficial, does not produce the striking results seen following its use in simple midduodenal obstruction in dogs, where life may be prolonged for as long as thirty days if forty to fifty cubic centimetres normal saline per Kg. be given for the first five days to a week after obstruction.

In attempting to study further the mode of action of the toxic factor we were struck by the fact that almost all of the work on the effect of injection of the toxins has been done on animals whose gastro-intestinal tracts were intact, and this applies in a measure at least to the work with closed loops, where for the most part the continuity of the tract was established after the isolation of the loop. The present work consists of a study of the effects on the blood chemistry and duration of life of histamine, in animals with intact gastro-intestinal tract and in those with high intestinal obstruction. Histamine was selected because of the similarity of its action to that of the toxic substance or substances which can be isolated from the bowel content of animals dead from intestinal obstruction, because of the fact that its pharmacological action is fairly well known and because, being available in the form of a pure salt, its dosage can be accurately controlled. Further, most of the evidence accumulated from many different studies indicates that the toxic agent in intestinal obstruction is some product of protein degradation—probably several related substances—and that many of the properties and effects of these substances are like those of histamine.

An attempt was made in this work to avoid overwhelming single injections of histamine and also to avoid intravenous injection, as it was felt that massive doses injected intravenously may provoke symptoms of shock, whereas the injection of small amounts (1 milligram) subcutaneously at hourly intervals, it was thought, should more nearly simulate the conditions imposed by the gradual absorption of toxic products from the obstructed bowel.

Pyloric Obstruction. (No. 266.)—In a dog are illustrated the typical changes observed in the blood of a dog with simple pyloric obstruction. The principal changes demonstrated in this experiment are: (1) The relative cell volume increased in the second blood sample but decreased again in the third sample. The erythrocyte size was unchanged in the last sample, but ordinarily there is observed a slight diminution in this value. (2) The hæmoglobin content of the cells remained practically unchanged, demonstrating that in this important constituent the red cells remained normal. (3) The serum protein and the nonprotein nitrogen increased. (4) The chloride fell markedly in both plasma and cells. (5) The CO_2 content of both plasma and cells increased in the second sample, but fell termi-

nally, presumably because of the increase of organic acids which is to be expected at this time. (6) There was a marked increase of the organic acid-soluble ester-P of the cells, evident in the figure for this fraction in the packed cells (84.5 milligrams per 100 cubic centimetres) and in the ratio of ester-P:RBC count. The next greatest change of the blood phosphorus was in the inorganic fraction in the plasma.

Normal Dog Injected with Histamine: Followed by Pyloric Obstruction and Repeated Histamine Injections. (No. 272.)—A normal dog was subjected to hourly subcutaneous injections of one milligram of histamine, in 1.0 cubic centimetres of 0.9 per cent. NaCl solution, for forty-eight hours. Food was withheld. Throughout this period the animal manifested no outward signs of ill effects of the injections at any time. Blood samples were taken for analysis before the injections were started and again at twenty-four and forty-eight hours. After sixteen days of rest a pyloric obstruction was created and immediately after six hours had been allowed to elapse for recovery from the ether anæsthesia the dog was subjected to the same hourly subcutaneous injections of histamine as before. Blood samples were again taken at the intervals indicated in the table. The injections of histamine in the unoperated animal were almost without significant effect on the blood. There was a slight but measurable diminution in size of the erythrocytes, 65.5 to 62.4 cubic microns, and a slight diminution of the chloride, more noticeable in the cells. The ester-P of the cells increased slightly. After pyloric obstruction, sixteen days later, the same injections of histamine were attended by rapid changes in the blood, as follows: (1) concentration of the blood, indicated by the increasing red blood-cell count and increased serum protein. (2) Loss of chloride and increase of CO_2 in both plasma and cells. (3) Increases of the total phosphorus, practically all in the ester-P fractions in the cells. These changes were in no wise different from those observed in other dogs with simple pyloric obstruction, but developed more rapidly. In the last blood sample, taken one hour before death (twenty-two hours after operation) after sixteen injections of 1 milligram doses of histamine, the magnitude of changes in the blood is, as in the previous experiment, approximately that seen in dogs with simple pyloric obstruction at seventy-two hours, or longer, after operation.

Pyloric Obstruction + Salt Solution + Histamine. (No. 297.)—In dogs with simple pyloric obstruction the parenteral administration of NaCl solution in appropriate amounts (around fifty cubic centimetres or more per kilo) prolongs life in the animals and diminishes the alterations of the blood. If the effect of histamine in hastening death in obstructed dogs is mainly one of stimulating gastric secretion and thus accelerating the losses of chloride from the body, then the administration of salt solution in sufficient amounts theoretically should protect these dogs as well as those with simple obstruction. The following experiment was performed to determine whether such protection could be obtained.

In a dog weighing twenty-one kilograms the pylorus was obstructed under ether anæsthesia, with the usual technic. Immediately after operation 1,500 cubic centimetres of salt solution were given subcutaneously. Again, at twenty-two hours after operation 1,000 cubic centimetres of salt solution were given. At thirty hours after operation a blood sample was taken and immediately afterwards hourly subcutaneous injections of one milligram histamine in 1.0 cubic centimetres 0.9 per cent. NaCl solution were started. (This interval of thirty hours before starting the histamine injections was allowed so that the dog might recover from the immediate effects of the anæsthesia and operation. A repetition of this experiment, in which both the histamine injections and the parenteral administration of salt solution were started immediately after operation, gave almost exactly the same results as shown here, so this time interval appeared to be unimportant.) Salt solution was again given at thirty-six hours and forty-eight hours, and another blood sample was taken at fifty-two hours after operation. In this blood sample No. 3 the cell chlorides were found to be low and in the next twenty-four hours the administration of salt solution was increased. In the last blood sample, at seventy-eight hours, the chlorides of both plasma and cells were again at practically the initial level. The nonprotein nitrogen had remained normal.

The dog was sacrificed after the blood sample taken seventy-eight hours after operation (forty-eight hours of histamine injections). The experiment had been continued long enough to demonstrate that the dog could be kept alive by the parenteral administration of salt solution well beyond the time at which death occurred in dogs with obstruction, similarly injected with histamine but not receiving salt solution. Were it not for the exigencies of the experiment—the large blood samples that had been taken, *etc.*—it seems likely that this dog could have been kept alive for even a longer time by this treatment.

Discussion.—In these experiments it is demonstrated that when dogs with pyloric obstruction are injected with small repeated doses of histamine, they develop more rapidly all the chemical changes of the blood which are ordinarily associated with intestinal obstruction, and die much more quickly than do the untreated dogs with simple obstruction. In normal unoperated dogs similar injections of histamine continued for even longer periods were without visible deleterious effects and caused only slight changes in the blood. Histamine thus injected is known to have a powerful effect in stimulating the secretion of gastric juice. In normal animals these secretions presumably pass through the pylorus into the intestine to be reabsorbed and again form part of the body fluids. However, in animals with obstruction and vomiting, such stimulation of the gastric secretion must accelerate the losses of these secretions from the stomach and therefore hasten the development of all the chemical changes which occur in the body in consequence of these losses. If one accepts the existing evidence that the alterations of the blood and body fluids ordinarily observed in simple high obstruction are due mainly to the losses of water and electrolytes by vomiting, it seems reasonable to believe that the same mechanism is operative in producing the altogether similar changes that are observed when dogs with obstruction are injected with histamine. It seems unnecessary to postulate a general toxic action of the histamine on the body tissues to explain the effects of histamine, in such doses as used here, in hastening death in the unobstructed animals. The immediate death with the symptoms of "shock" that follows the intravenous injections of larger doses of histamine may be due to a different mechanism.

Work is in progress to determine whether or not the effects of subcutaneous injections of the toxic substances (proteoses or amines?) from the contents of the obstructed or strangulated intestine, or from closed loops in dogs, are closely analogous to this effect of histamine. The absorption of such substances conceivably might be sufficiently rapid to cause immediate death with manifestations like those observed after the intravenous injection of these toxic substances, but in clinical experience such a circumstance is certainly exceptional. It is likely that the slow absorption of these substances will be found to have an effect similar to that of histamine in stimulating the flow of gastric juice (Dragstedt and Dragstedt (1922)); if this be true, then it is possible that a most important effect of the slow absorption of toxic substances from a strangulated portion of bowel consists of an acceleration of all those chemical or metabolic effects which ultimately cause death.

STUDIES IN TUBERCULOSIS

By Pol N. Coryllos, M.D.
of New York, N. Y.

The frequency of atelectasis of the diseased portion of the tubercular lung, and its importance in the evolution of the disease, have been already studied (Rev. of Tuber., June, 1933).

The strict aërobic character of the tubercle bacillus, especially of the human species, shown by Novy and recently by Loebel, Richardson and Shorr, the exclusion of oxygen in the affected portions of the lung following the production of atelectasis, the clinical improvement noticed in cases in which atelectasis or fibrosis is present, and more especially the results obtained by surgical collapse of the lung, gave me the idea of a possible relation between these phenomena.

Experimental investigation on this subject is being carried on this year. There are not, as yet, any definite results to be reported. I was asked to present in a few words the technic which has been followed so far.

As the experimental animal I chose the dog. This animal, however unsuitable for thoracic investigation because of the complete permeability of its mediastinum to air and even to fluids, presents a number of special features favorable to this kind of experimentation; first, the trachea and bronchi of a dog of ten kilograms are almost as large as in the human, which makes intratracheal work and exploration by means of the ordinary bronchoscopic set easy and effective; second, previous extensive work in experimental atelectasis, pneumonia and suppuration of the lung have familiarized me with the interpretation of radiographical changes in their lungs; third, the intraperitoneal method of anæsthesia by means of sodium amytal, which has been used for several years, permits the avoidance of any disturbing irritation of the lungs.

Tuberculosis was given to these animals by intratracheal injection of tubercle bacilli emulsion, using for the purpose cultures of previously well-established virulence. Two varieties have been used so far, both human, R.1 and H.37, both given to me by Doctor Petroff, of the Trudeau Laboratory in Saranac Lake.

New animals or animals previously sensitized have been used. In new animals 0.5 to 1 cubic centimetre of R.1, or H.37 emulsions (0.0001 of culture in 1 cubic centimetre) was injected into the bronchi of the lower or the upper lobe. Tuberculosis has been produced as a rule with H.37.

Other animals were inoculated subcutaneously with R.1, still others with H.37. After five to seven weeks intrapulmonary injections were given. The results so far obtained are most interesting. They are still too recent to be reported.

In other animals small amounts (0.1 cubic centimetre) were injected into the bronchus, followed by 0.5 cubic centimetre injection of the same

culture into the same bronchus three, four and five weeks later, with the idea of obtaining a local sensitization of the organ.

Interesting results thus far seen include massive involvement with clean-cut atelectasis in the affected lobe, a gelatinous pneumonic lesion, caseation and even spontaneous pneumothorax.. Thus, a difficult part of the problem, which is the experimental production, at will, of a given form of tuberculosis in the lung of the dog, seems to be almost solved. The second part of the problem, namely, the influence of experimental obstruction of the bronchus leading to the diseased lung, will begin shortly.

FURTHER STUDIES IN PNEUMOCOCCIC BRONCHIAL OBSTRUCTION

POST-OPERATIVE ATELECTASIS, POST-OPERATIVE PNEUMONIA AND LOBAR PNEUMONIA

By George L. Birnbaum, M.D.

of New York, N. Y.

The question of the pathogenesis, prevention, and treatment of post-operative atelectasis and post-operative pneumonia are of considerable practical importance in surgery. In previous publications Doctor Coryllos and I have pointed out the importance of complete bronchial obstruction with viscid pneumococcic exudate in the pathogenesis of these post-operative complications as well as in lobar pneumonia.

In lobar or massive post-operative atelectasis, pneumococci, especially group 4, are always present in the sputum. Similarly, lobar pneumonia is almost always associated with pneumococci. This incidence is explicable on the basis of the type of exudate which pneumococci produce in both instances—an exudate viscid enough to occlude a lobar bronchus and cause air absorption and atelectasis. This bronchial occlusion is facilitated or aided in post-operative cases by such contributory factors as the abolition or reduction of cough reflex by the anæsthetic or narcotics, by voluntary inhibition of painful cough or breathing, and by constrained posture and thoracic or abdominal dressings which may hamper respiration. In contrast to lobar atelectasis and lobar pneumonia, lobular atelectasis and lobular pneumonia are usually associated with other organisms than the pneumococcus, such as staphylococci, streptococci, *etc.*

By physical and röntgen signs or even by the gross pathological appearances, it may be impossible to distinguish post-operative atelectasis, post-operative pneumonia and lobar pneumonia. In a general way, the clinical toxicity is proportionate to the virulence of the pneumococcus concerned. In lobar pneumonia there is a more marked degree of pneumococcic cellulitis and alveolar exudation, factors which may make the underlying or basic atelectasis less evident in the gross pathological and röntgen pictures.

Experimentally, various phases of the question were studied in animals

by means of bronchial obstruction with a special balloon, and by the intrabronchial instillation of pneumococcus cultures and human pneumonic sputum. Instillation of pneumococcus cultures or of human pneumonic sputum into the bronchi of dogs produced either evanescent symptoms or the clinical and röntgen pictures of lobar or massive atelectasis. Some of the latter cases went on to spontaneous recovery; others terminated fatally. Presumably, the virulence of the pneumococcus concerned was the factor determining the outcome. The toxic or fatal conditions in this group were clinically comparable to lobar pneumonia, whereas the less toxic ones in which recovery occurred were clinically comparable to lobar or massive atelectasis. In man, the same difficulties of diagnosis are encountered, and the differential diagnosis between post-operative atelectasis, post-operative pneumonia and lobar pneumonia may rest largely on the factor of toxicity, when the other symptoms and signs run closely parallel. The symptom complex in pneumococcic bronchial obstruction is variable. The immediate cause is bronchial obstruction and the underlying or basic pathological condition produced is alveolar air absorption and atelectasis. The clinical aspect, however, depends on the size of the occluded part of the lung, the duration of the bronchial occlusion, the type and virulence of the pneumococcus concerned, the character and the amount of alveolar exudate and the complications which may arise.

The fundamental soundness of our concept has recently been challenged by the contention that early in clinical and experimental lobar pneumonia little or no signs of atelectasis are found clinically or röntgenographically; further, that when röntgen signs of atelectasis are found they are slight and the shift of heart and mediastinum to the affected side may then be explained by an "increased elastic tension" of the involved lobe which hinders inspiratory inflation of the pneumonic lobe. The present studies which are shortly to be published were undertaken with the view of testing the validity of these contentions which we have found to be entirely erroneous.

BACTERIOLOGICAL STUDIES

By Edward W. Saunders, M.D.
of New York City, N. Y.

Since the early days of bacteriology, microörganisms have been found in cultures made from malignant growths. The chief criticism of the results has always been the lack of constancy in the findings—bacilli, diphtheroids, cocci, streptococci having all been isolated from the same types of tumor.

The recent development of bacteriology, particularly the increasing evidence that the external form of a microörganism means nothing as regards its classification and that many, if not all, microörganisms seem to pass through a developmental cycle in which all of the forms—rods, diphtheroids, cocci and granules—may appear at some stage or other, made it seem worth

while to reconsider the problem of the bacteriology of malignancy from these newer points of view.

Our work thus far leads us to the belief that we are dealing with an identical streptococcus, proved so bacteriologically by agglutination, cross-agglutination, and agglutinin absorption, which has been isolated by tissue culture seventy-four times as shown in the table following:

Gastric ulcer and Ca	35
Breast Cancer	11
Breast Cancer blood serum	2
Cervix	8
Rectal cancer	2
Ulcerative colitis	2
Hodgkins gland	2
Thyroid	1
Mouse Cancer	6
Milk	3
	74

It is identical with a streptococcus isolated from milk coming from cows with mastitis, and is not identical with any other streptococcus tested.

The method of culture is best demonstrated by Fig. 1, which shows two separate areas of breast carcinoma connected by a lymph-vessel. The organisms are growing from the lymph-vessel. Immediately at operation pieces of tissue are excised and carried down into ½ per cent. semi-solid hormone agar. This gives the necessary partial anaërobiosis and partial tension needed for its growth. It will not grow originally in broth under aërobic conditions.

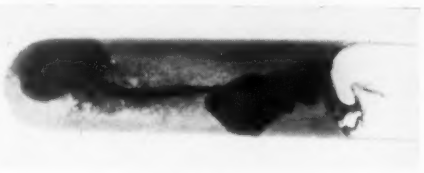


FIG. 1.

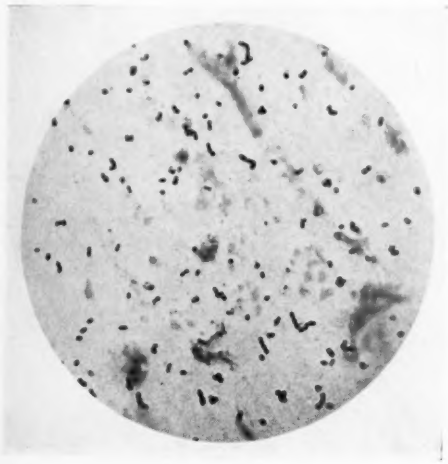


FIG. 2.

From all the lesions of the gastro-intestinal tract the cultures were originally streptococci, as shown in Fig. 2.

However, from the blood-serum, once from the breast, and in both Hodgkin's glands, the original culture was a diphtheroid, and required repeated transplants to change it to the streptococcus. (Figs. 3 and 4.)

It has been isolated once from a few cells of a tissue culture of mouse carcinoma given to us by Doctor Chambers, the cells isolated and planted

in a droplet of media by the single cell technic. (Fig. 5.) In this case the small granular stage was predominant.

FIG. 3.

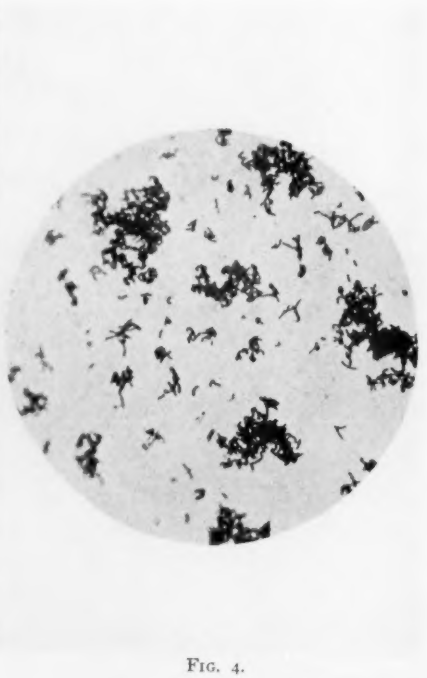


FIG. 4.

FIG. 5.

FIG. 7.

When a gastric strain originally a coccus was grown in human blood-serum, gelatin media, the coccus reverted to the first morphological phases

of the diphtheroid, showing clubbing, parallelism, and granules. (Fig. 6.)

Pathologically, very little, if any, cellular reaction occurs from one inoculation of the organism into animals—best demonstrated by the infected thread passed through the stomach of the dog. (Fig. 7.)

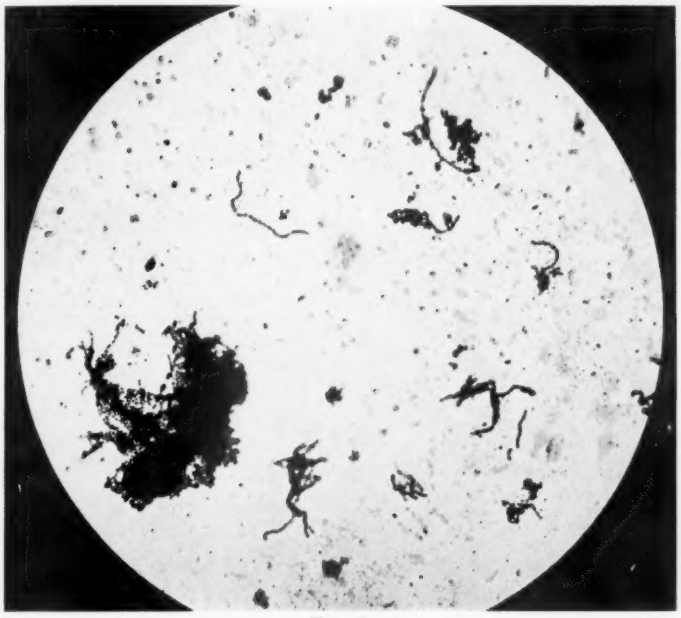


FIG. 6.

It does not rule out the fact, however, that given the right morphological phase of the organism, the right environment, and the right lack of resistance of the host, it might be pathological.

By showing that all of these morphological forms—bacillus, rod, diphtheroid, coccus and granule—can emanate from the one single cell isolated by the single cell technic, the cultivation of a multiplicity of organisms, as previously believed, is ruled out.

Our problem at the present is whether or not the granular stage may possibly exist within a cell without killing the cell.

THYROID SECRETION

BY JOHN STAIGE DAVIS, JR., M.D.

OF NEW YORK, N. Y.

THE part played by iodine in various thyroid dyscrasias has been extensively investigated, as to both its source and mode of action; while on the other hand the constituent that binds iodine to form the thyroid's active principle, thyroxin, has been almost entirely neglected. The relationship of iodine and the amino-acid, tyrosin, to thyroxin is shown in Fig. 1.

In the investigation being carried on at present, we are attempting to remove the amino-acid constituent of the molecule. The method of approach

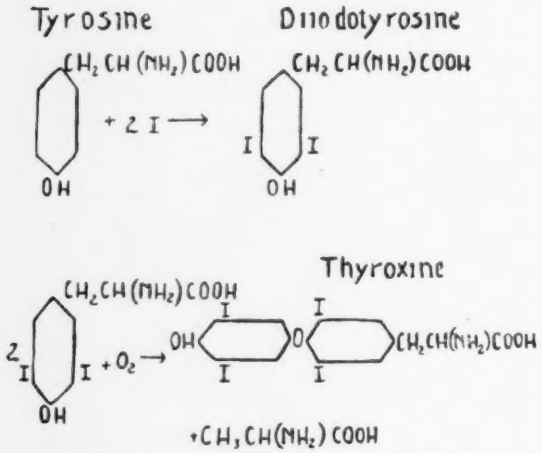


FIG. 1.—Formation of Thyroxine from Tyrosine.

was suggested in a paper published by Sweet in 1918. He noticed that a type of colloid goitre was developed in dogs about one month after their pancreatic ducts had been ligated. This suggested that perhaps the removal of trypsin from the intestinal tract resulted in incomplete hydrolysis of the proteins to the amino-acid stage. In this event tyrosin would not be available for the formation of thyroxin —and iodine would be stored in the gland. That iodine is stored in the gland under these circumstances is shown in Fig. 2, taken from Sweet's paper.

Groups	Number of Dogs	Iodine of Thyroid mg. per 100 Gm. Dry Gland Maximum	Minimum	Average
Normals	18	267	0	93.9
Depancreatized	7	992	113	367.8

FIG. 2.

FIG. 3.

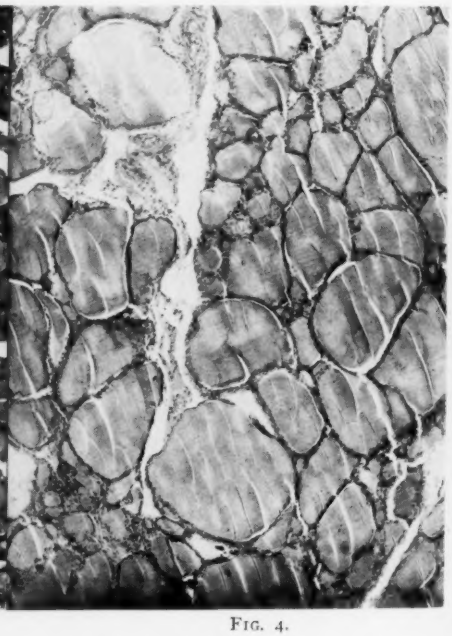


FIG. 4.

During the past eighteen months experiments have been done in this laboratory on sixty dogs. Various drugs and operative procedures have

been used to interfere with the supply of the constituents which are used by the thyroid for the formation of thyroxin.

Fig. 3 is a photomicrograph of a normal dog's thyroid while Fig. 4 illustrates a gland six weeks after the dog has had his pancreatic ducts ligated.

The conclusions are not definite. If the dogs are fed iodides or if diiodetyrosine is introduced into the vein, they lose weight and die rapidly. The iodine storage in the gland is immense. If the dogs are given thyroxin intravenously they live indefinitely. Tyrosin by mouth will not prolong life.

The chief value of the work is in the presentation of a new method of approach in the study of thyroid disease.

THE FUNCTION OF THE BILIARY TREE

By John E. Sutton, Jr., M.D.
of New York, N. Y.

Doctor Sutton presented five lantern slides illustrating the functional relationship of the biliary tree to the gall-bladder.

The first slide, from the liver of a dog forty days after cholecystectomy, showed dilation of an intrahepatic bile-duct with hyperplasia of the epi-

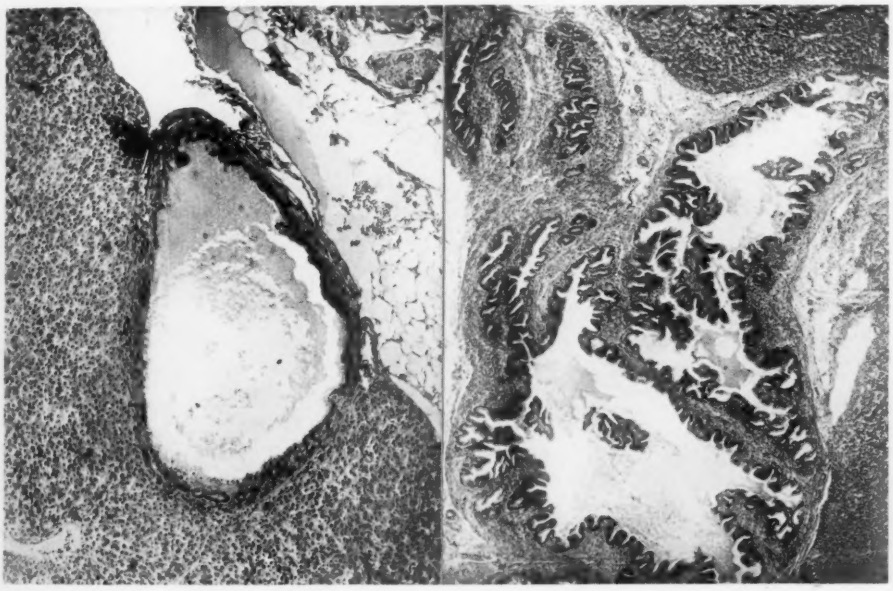


Fig. 1.—Normal control.

Fig. 2.—Vitamine D deficiency.

thelium. The surface of the lumen of the duct was greatly increased by mucosal folds and villi projecting from its surface. Histologically, the cells covering these projections resemble those of the gall-bladder mucosa. (Annals of Surgery, January, 1930.) These mucosal folds which are found

after cholecystectomy, when stained with Sudan iii, are found to be filled with fine droplets of a lipoid after a meal rich in fat. The most important lipoid normally found in the bile is cholesterol or its esters and the examination of frozen sections of these specimens under the crossed Nichol prisms gives suggestive evidence. Such a slide shows large amounts of doubly refractile material in the mucosa and submucosa of the duct projections. Our work suggests that a function of the gall-bladder and the biliary tree may be concerned with sterol metabolism and with that thought in mind feeding experiments have been undertaken. Two groups of newly hatched chicks were used: one, the control group, was fed on a normal diet; and the other was deprived of the antirachitic factor (vitamine D) for the first eight weeks of life. The intrahepatic ducts of the control group showed an almost smooth mucous membrane (Fig. 1) while the ducts of the chicks fed on the deficient diet exhibited pronounced hyperplasia of the epithelium with many folds, villi and septa (Fig. 2). Avian metabolism differs in many respects from that of mammals, and these observations, while suggestive, must be evaluated with caution. Thus far we have not had sufficient material from mammals fed on deficient diets to draw any definite conclusions.

LIVER INSUFFICIENCY

By W. Morris Weeden, M.D.
of New York, N. Y.

The usual operation of cholecystenterostomy results in a regurgitation of intestinal contents into the gall-bladder with, finally, generalized cholangitis. It was thought that an operation, such as shown in the accompanying schema

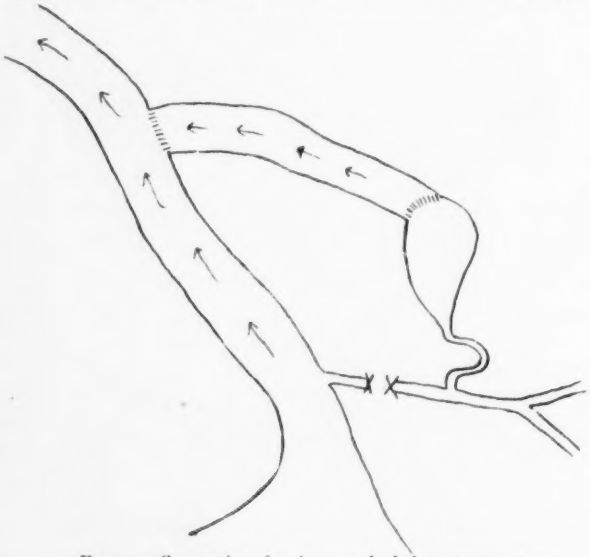


Fig. 1.—Suggestion for improved cholecystenterostomy.

might overcome the entrance of intestinal contents into the gall-bladder by the interposition of a segment of intestine so arranged that its peristaltic

movements would tend to pass any contents back into the main intestinal current.

It was found that the greater number of animals so operated upon died within a short time with every evidence at autopsy that there had been no secretion of bile.

Three years ago, having had one of those tragic and sudden deaths following cholecystectomy said to be due to liver insufficiency, I became interested in this subject. Doctor Sweet suggested that some light might be thrown on this condition by repeating his experiment. This I have done in a number of dogs, varying the operation at times by inserting the cut proximal end of the common duct into the intestinal loop instead of making an anastomosis with the gall-bladder. While the results have varied to some extent, yet, in a certain number of cases, death has occurred twenty-four to thirty-six hours after operation. These dogs show very little, other than loss of appetite and high temperature. Autopsy, in some cases, reveals a congestion of the mucous membranes of the duodenum similar to that seen in anaphylactic shock, and a total absence of bile in the liver, intestine and, at times, even in the blood. Apparently in these cases the liver simply stops functioning. It has a dark, congested appearance and in some of the dogs which lived a longer period it becomes almost leathery in consistence.

We are unable to draw any conclusions as yet from these experiments, but expect to continue them and to study the metabolism of the dogs after the operation.

HYPOGLYCÆMIA FOLLOWING HYPOPHYSECTOMY AS AN EXPLANATION OF SO-CALLED CACHEXIA HYPOPHYSEOPRIVA

By William Mahoney, M.D.

of New York, N. Y.

The anterior lobe of the pituitary body has already yielded growth, sex, lactation, thyreotropic, and fat mobilization hormones. To study these active principles puppies eight to ten weeks old were hypophysectomized, and this is a preliminary report of a by-product of the original undertaking. It concerns another principle of the probable central control station of the entire endocrine system, and opens a rich vein in the metabolic mine of the carbohydrates.

Clinical evidence has long existed pointing to a pituitary-carbohydrate relationship, and this has been supplemented by a variety of disconnected experimental support. With this present link in the chain it may be predicated that there is a pituitary principle, most likely in the anterior lobe, which plays a leading rôle in the metabolism of carbohydrates, its action antagonistic to insulin.

For many years the debate as to the absolute need of the pituitary body for the maintenance of life was held, the issue being long undecided because of operative difficulties, among other trials. Some animals were finally successfully carried over after proven complete hypophysectomy, and the issue was decided. However, the difficulties were not altered, and hypophysectomized dogs continued to die of a train of symptoms which Cushing

called "cachexia hypophyseopriva." This state is characterized by a loss of normal interest in the surroundings, irritability, unsteadiness of gait, anorexia, arching of the back, lethargy, fine muscular twitchings, hypersalivation, coma, and death. This was the difficulty to be overcome in preparing the puppies for studies which were intended to last for months, for these very symptoms occurred even after the most meticulous operative care checked by absolutely negative post-mortem studies. In puppies the symptoms supervened after twenty-four hours, while in the mature dogs the trouble began after a three-day lapse.

In observing these happenings repeatedly the syndrome resembled in some points the train of events in humans who have hypoglycæmic crises. So, carbohydrate therapy was given to the cachectic animals intravenously, intraperitoneally, subcutaneously, and by stomach tube. By whatever method of administration, there was improvement, though after a time symptoms recurred only to be again relieved by more carbohydrates, these alternating states lasting for days. To anticipate this difficulty feeding was begun immediately after recovery from anæsthesia, even by stomach tube if necessary, and, if adequate carbohydrates were supplied, "cachexia hypophyseopriva" did not supervene.

Blood-sugar studies have demonstrated in puppies that have not been fed post-operatively a normal level for about twenty-four hours, then a rapid fall even to an unreadable content before exitus. The early symptoms of mischief manifest themselves at about the fifty milligrams per 100 cubic centimetres level by the Benedict modification of the Folin-Wu method. Control puppies fasting for an equal period had no such variations. Sugar has never appeared in the urine.

That the carbohydrate metabolic disturbance alone is responsible for the old picture of "cachexia hypophyseopriva" we cannot say, nor does it seem reasonable. Rather, not alone has the pancreas been given free rein, but all the glands of internal secretion, though perhaps less impressively, are allowed to act without the regulatory influence of the pituitary body. However, hypoglycæmia is the likely explanation of fatalities previously attributed to the so-called "cachexia hypophyseopriva."

THE USE OF RIBBON GUT IN THE REPAIR OF KIDNEY WOUNDS

By Oswald Swinney Lowsley, M.D., and Courtney Craig Bishop, M.D.
of New York, N. Y.

Incision of the kidney cortex as a method of providing free access to the renal pelvis, whether for purpose of removal of calculi, or for relief of undrained and infected urine, has been recognized as an acceptable surgical procedure for nearly seventy years. The early problem of selection of the site best suited for incision was clarified by the researches of Tuffier and by the anatomical studies of Broedel. Innumerable variations in the method

of closure of the wounds were introduced by the reports of many workers describing both experimental and clinical studies.

It is commonly accepted that nephrostomy is followed by impairment of renal function; the cause for this has been attributed by some to the incision of functional cortical and medullary tissue and by others to the ischæmia and subsequent scarification of functional tissue peripheral to the through-and-through sutures used for closure of the wound. Deming[1] has supported the latter point of view by demonstrating, by means of corrosion models, that the major damage results from the circulatory changes produced by the through-and-through sutures; variations in the figure of the sutures produced little if any significant difference in the end-result.

The investigations described in this report represent an attempt to formulate a technic for closing nephrostomy wounds by means of a flat ribbon laced about the kidney in place of the conventional type of suture which pierces the renal tissue. For such purposes, it would be necessary to have an absorbable, flat ribbon of sufficient strength to permit the usual amount of tension to which ordinary catgut is subjected. The ribbon would need breadth in order to produce a definite directed force, which at the same time had no cutting or constricting effect on the renal substance. The material would need to be of such thinness as to permit complete flexibility and ease in handling. These specifications were presented to Davis and Geck, Inc., who developed in their laboratories the ribbon gut used in these experiments.

The suture material so prepared consists of flat ribbons of untwisted gut, 45 to 65 centimetres in length, 1.8 to 2.0 centimetres in width and in thickness no more than that of fine rice paper. Sterilized and packed in a manner entirely similar to that of the usual catgut, it remains thoroughly pliable. When exposed to air, however, the material dries rapidly and becomes difficult to handle; moistening with saline solution readily restores its original pliability. The material has been tied after the customary manner and the knots have proven adequate and satisfactory; any tendency for the ribbon to twist on itself has been confined to a matter of a centimetre immediately adjacent to the knot and has in no way interfered with the desired effect, *i.e.*, a broad, flat surface. The manufacturer's *in vitro* experiments demonstrated that the material was absorbable in four to five days.[2] The *in vivo* experiments conducted in this study have not borne out this finding; the material has been found still intact, though of lesser tensile strength, at the end of twenty-three days.

The plan for the present series was to make the conventional type of nephrostomy incision in the kidneys of animals and then close the wounds by encircling the organ with two or three bands of flat ribbon gut. At operation, the closure would be expected to accomplish, firstly, an adequate approximation of the cut surfaces, and secondly, complete and permanent hemostasis. Post-operatively, the objective of the experiment was simply to establish whether or not such a procedure was compatible, on the one hand, with life

and continued good health, and on the other, with satisfactory healing of the organ.

The operation itself is neither difficult nor time-consuming. The kidney must be located, completely freed of all adjacent adhesive tissue and delivered into the wound. The chosen site for nephrostomy is located and marked; before the actual nephrostomy is done, however, all preparations for the closure are carefully made. The ribbon gut is looped beneath each pole, adjacent to but not impinging upon the pelvis and its associated vascular pedicle. In the development of the technic, it was found necessary to create some means to prevent the ribbons, when once placed, from slipping lengthwise over the poles of the kidneys. This was accomplished by constructing straps of kidney capsule about three millimetres in width on both surfaces of the viscus at either pole. Through these straps were threaded the free ends of the ribbons; the loop of ribbon was well fixed by this means beneath the pole and the free ends could be readily crossed on the lateral curvature of the organ, *i.e.*, at the site of proposed nephrostomy. After incision through the avascular line of Broedel, closure was accomplished by gently tightening the ribbons about either pole and tying them across the line of incision. A small piece of freshly cut fat introduced into the wound admirably aided in hemostasis. As an added precaution against slipping, the long ends of each ribbon were tied each to the other. When needed to provide thorough hemostasis, a third ribbon was placed in the form of a figure-of-eight about either pole and the long ends crossed and tied over the line of incision. It was found necessary to use this latter figure in only two instances, since in all others the two single ribbons afforded completely adequate closures. When the closure was considered complete the kidney was returned to its fossa and the wound closed without drainage.

The procedure has been carried out in fourteen animals. Originally six rabbits were done and after the method had been found practical in this group, the work was immediately extended to dogs, with which it has since been continued. At the time of writing, ten operations have been performed on eight dogs. There has been but a single fatality, that occurring in a young dog five days after operation; autopsy showed a diffusely suppurating kidney with generalized sepsis. In all the others the wounds have healed *per primam*, without infection and without urinary leakage. The animals have regained or increased their pre-operative weight, and to external appearances have seemed in the best of health. In the dogs there has been a period of toxicity, manifest in loss of appetite and interest, lasting from the second to the fifth post-operative day. The animals have been sacrificed at intervals of two to eight weeks post-operatively; the kidneys were removed, examined grossly and prepared for microscopical study. In none was there evidence of old or new hæmorrhage. In all the specimens the nephrostomy has been completely healed; in none has there been distortion of the normal configuration of the organ. The specimens have weighed the same as their respective normal fellows; in none has there been gross evidence of necrosis

nor circulatory damage. The suture material (experimental stock No. 362) has been found in place and intact up to eight weeks after operation. There is relatively little foreign-body reaction imbedding the ribbons.

One of us has carried out the procedure in five instances of nephrostomy in human beings. Of this group four cases were done for the relief of nephrolithiasis and the other for drainage of a pyonephrosis. The operative procedure has been the same as described above. In each of these cases the renal pelvis has been drained by a small soft rubber catheter for two to three days, and the renal fossa has been drained by a single folded rubber tissue drain. At the completion of the operation the kidney is suspended by the Deming technic.[3] All these patients have recovered without complications and have experienced a convalescence not at variance from the usual. In none has there been secondary bleeding. The drains have been removed on the fifth or sixth day and the wounds have been closed and dry by the twelfth day post-operatively.

The complete details of this present preliminary study are appearing elsewhere in the near future. No effort has been made in this group of investigations to determine the results in terms of the functional efficiency of the kidney; this aspect of the study is to be reported in a subsequent paper. The present undertaking has established the fact that closure of wounds of the kidney is technically possible through the use of ribbon gut which is laced about the kidney in such a way as to replace completely the more conventional type of through-and-through suture of catgut. The technic of the procedure has been described. It has been demonstrated that closure by this method produces satisfactory approximation of the cut surfaces, and also thorough and complete hemostasis. It has been further demonstrated that kidneys so repaired heal completely without temporary or permanent urinary drainage, and that such an operation is compatible with a complete and permanent return to health.

REFERENCES

[1] Deming, C. L.: Renal Circulation Following Various Types of Nephrostomies. Am. Jour. Surg., vol. iv, pp. 424–431, 1928.
[2] Clock, Ralph O.: Personal Communication.
[3] Deming, C. L.: Nephroptosis; Causes, Relations to Other Viscera and Correction by a New Operation. Jour. Am. Med. Assn., vol. xcv, pp. 251–257, 1930.

THE MUCOSA OF THE GALL-BLADDER

By John G. Schmidt, M.D.
of New York, N. Y.

The microscopical examination of the mucosal cells of the fresh gall-bladder presents an unusual picture. More than fifty years ago, Virchow, in the study of fresh teased specimens of gall-bladder mucosa, described the cells as being filled with refractile globules, which he considered to be fat in the process of absorption. With the development of modern pathological

technic, involving the fixing and staining of tissues with solutions composed largely of fat solvents, this picture was lost and its possible significance forgotten.

The technic used is simple and consists merely in picking a minute piece of the mucosa and placing it in a weak formalin solution under a cover slip; a few gentle taps on the cover slip serve to break up the tissue so that individual cells may be made out. There was then shown a lantern slide, obtained from the gall-bladder of a healthy dog, which, for three days previous to the operation, had been given a daily half pint of heavy cream, in addition to his regular diet; he was then killed with ether inhalation and the gall-bladder immediately removed. This organ appeared, grossly, to be entirely normal, the mucosa however, having a somewhat milky appearance, most marked, at the ampulla and in the cystic duct. The slide was immediately made in the manner just described, and adequately shows the globules packing the cytoplasm of a row of mucosal cells. Another slide is the same field with the Nicoll prism attachment, giving the affect of doubly refractile material with polarized light. The "Maltese Cross" effect produced by some of the globules, which is believed by many to indicate the presence of the cholesterol esters, can be made out.

Fresh human gall-bladders obtained at operation have also been examined by this technic and pictures approximating this were seen, especially in those presenting grossly the so-called "strawberry" or cholesterosis appearance.

What the exact implication of this is, we are not prepared to say. We have revived these old observations merely as evidence of an active rôle, possibly that of fat absorption, being played by the epithelium of the gall-bladder; and we offer this as a small contribution to the present knowledge of the function of the gall-bladder.

THE FORMATION OF GALL-STONES

By Joshua E. Sweet, M.D.

of New York, N. Y.

I am convinced that the gall-bladder has a function other than that of a mere reservoir for bile. When one finds such a complex valvular arrangement in the cystic duct as is formed by the valves of Heister, it is difficult to think otherwise than that such a device is designed to prevent emptying; and when one studies the extremely complicated arrangement of the mucous membrane, one must feel that the organ is designed for absorption. The work presented by Doctor Schmidt is, to my mind, proof that the gall-bladder cells are concerned with some active process in lipoid metabolism. The work which Doctor Sutton has shown points, we believe, to a compensatory hypertrophy throughout the biliary tree, after removal of the gall-bladder, and the second part of Doctor Sutton's work suggests that the real function of the biliary tree may be connected with the metabolism of sterols, or, more specifically, vitamin D. On the basis of such an hypothesis, the gall-stones which are composed mainly of cholesterol may represent a disturbance in vitamin D metabolism, a disturbance comparable to the formation of kidney stones when the vitamin A metabolism is upset.

If the gall-bladder is an organ of absorption, gall-stones may form under

either of two circumstances: The absorbing membrane may be destroyed, as is often found in the association of chronic cholecystitis and cholelithiasis. Infection is, however, not necessary to the formation of stones as is shown by the finding of chronic cholecystitis without stones, and, conversely, the finding of stones in a perfectly normal gall-bladder.

This latter finding—stones in a normal gall-bladder—I believe is to be explained on the hypothesis that the material furnished to the gall-bladder by the liver is pathological, that is, nonabsorbable, and, therefore, it must collect.

How, then, does cholecystectomy cure cholelithiasis? In the case of chronic cholecystitis with cholelithiasis, obviously, by removing the cause and effect. In the case of cholelithiasis of liver origin, I believe the good effect of cholecystectomy can be explained only by the secondary effect of cholecystectomy upon the anatomy and the function of the duct system. The normal bile-ducts become enormously dilated after cholecystectomy, and through this widened tube the pathological liver product escapes into the intestine; and, whereas bile normally flows into the intestine practically only during the periods of active digestion, after cholecystectomy it dribbles constantly into the intestine, *i.e.*, there is no opportunity for collection and precipitation. But this has not cured the basic trouble, *i.e.*, the metabolic upset in the liver.

But I suspect this does not always happen and I am convinced that this failure to obtain free drainage after cholecystectomy is the real explanation of common-duct stones following cholecystectomy.

There is a type of common-duct stone which is composed of a dark brown mass of pigment and salts which is characterized by its tendency to break into many fragments on drying. I suspect that the explanation of this type of stone is to be sought in the anatomical relationships between the bile-ducts and the pancreatic duct. A stenosis at the common opening in the normal arrangement of bile and pancreatic ducts would cause a mixing of the two secretions within the duct system which might readily produce a precipitation of the salts and pigments of both secretions.

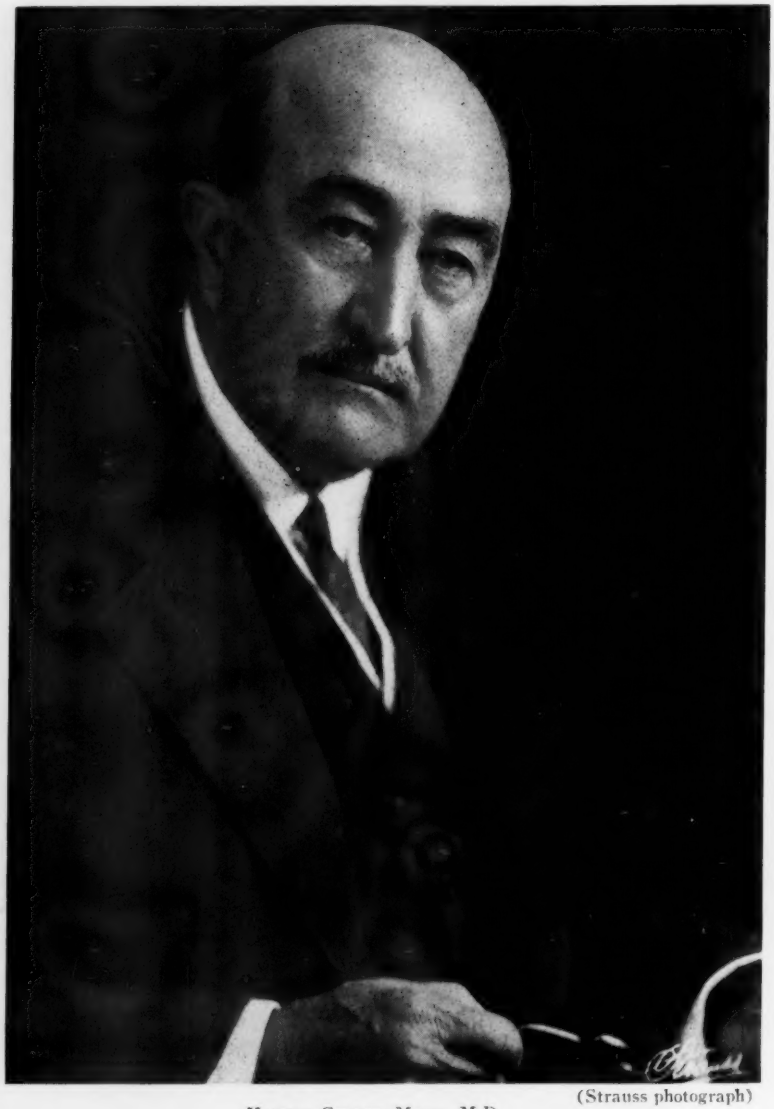
Under such circumstances cholecystectomy might produce a cure as it apparently did in one case from which I obtained the stone, but in another, which I owe to Dr. Guildford Dudley, and which I trust he will bring before the Surgical Society at some future date, a cholecystectomy was done, a second operation was performed for common-duct stones, and, finally, Doctor Dudley removed a remarkable structure from the common duct, a cast of the right and left hepatic ducts, the common hepatic duct, the stump of the cystic duct, and the beginning of the common duct. Manifestly the accepted surgical procedure, cholecystectomy, was not curative in this case. I believe that surgery must devise some other procedure to meet this particular condition of common-duct stones.

MEMOIRS

HARVEY GILMER MUDD

1857-1933

Dr. Harvey Mudd was born in St. Louis in 1857. His father was Henry Thomas Mudd, a man of affairs; his mother, Sarah Elizabeth Hodgen, a sister



(Strauss photograph)

Harvey Gilmer Mudd, M.D.

of the distinguished surgeon, John T. Hodgen. There were two brothers, Henry H. Mudd and Seeley W. Mudd. The former, who was older, became a distinguished surgeon, the other a distinguished mining engineer. There were

two sisters: Fannie, who died after graduation at Monticello, Illinois; the other, Elizabeth, married Doctor Lemen of Denver, Colorado. All the family enjoyed the opportunity of a thorough education. Harvey's family moved to Kirkwood in his second summer because of his health, and he attended school in this cultured suburb of St. Louis, later commuting to the city for his high school work. After graduation from Central High he entered Washington University where he took two years of academic work, leaving there in 1878. His uncle, Doctor Hodgen, was at the zenith of his most distinguished career and his brother, who was engaged in practice with Doctor Hodgen, had already made a name for himself.

As might have been expected Doctor Mudd then entered medicine, enrolling in the St. Louis Medical College where his uncle was dean and his brother a professor, and he graduated in 1881 in the first class under the three year curriculum. He then entered the St. Louis City Hospital as an intern and also took part of his service at the Female Hospital, which completed the year 1881-1882.

In the St. Louis Medical College he became a demonstrator of anatomy in 1888, then a lecturer on osteology, and later professor of osteology and regional anatomy. He was professor of fractures and dislocations for several years, up to the time of the union of the St. Louis Medical and the Missouri Medical Colleges in 1899. Then he became professor of clinical surgery but after the combination he did less teaching than formerly. When the reorganization of the school took place in 1909 Doctor Mudd remained as professor of clinical surgery, and at his death he was Emeritus in Surgery.

After returning to St. Louis from abroad in 1887, where he had spent two years studying in Vienna, Berlin, Paris, London, and Edinburgh, he started in practice with his brother, Henry Mudd, rising to a position of prominence on sure and certain steps. While they had work all over the city their chief activities were centred about St. Luke's Hospital where the elder brother was chief of staff, and on his death in 1899, Harvey Mudd was elected to this place which he ably filled for thirty-three years up to his death. St. Luke's Hospital remained throughout his life his chief interest, he being not only chief of staff, but chief surgeon and a member of the board of directors. His constant interest and careful direction were responsible for the fine development of the institution. St. Luke's showed his influence in every department and whatever success it has obtained is largely due to his coöperation. There was no activity in the hospital that he didn't have a voice in. Here he did most of his surgery, and it was in the practice of surgery that he made his greatest name.

He had a keen ability at diagnosis and a training in clinical medicine and surgery that made him a most helpful consultant. He was among the first to do extensive breast operations and his fine results gave him a large clientele in this class of cases. In abdominal surgery he had his greatest successes, and he carefully followed the advances in this field so that he was always among the leaders. It is hardly fair to stress any branch of surgery as his special favorite

because he was essentially a general surgeon, taking as much pride in the excellence of his thyroid work as he had satisfaction from his skill in handling fractures, particularly those about the hip and thigh, where he could use better than anyone else the Hodgen splint that he had learned so well how to apply from his inventor uncle, Doctor Hodgen. He gave considerable attention to genito-urinary surgery in the earlier days of this specialty and was a member of the Association of Genito-Urinary Surgeons of America from the year 1899, and its president in 1908. He was a member of the American Surgical Association and its vice president in 1920. He took a keen interest in the St. Louis Surgical Society from 1903 until his death. He also had membership in numerous scientific societies, the St. Louis Academy of Science, the Archaeologic Institute, the International Surgical Association, the Society of Physico Chim de Palermo. He was an active supporter of the St. Louis Medical Library from its inception up to the time it was taken over by the St. Louis Medical Society. He was also a member of the College of Surgeons.

In 1892 Doctor Mudd and Miss Margaret de la Plaux Clark were married. The son, Stuart Mudd, was born in 1893. He now lives in Philadelphia where he is associate professor of experimental pathology in the University of Pennsylvania. Mrs. Mudd and Dr. Stuart Mudd were with Doctor Mudd when he died in Boston, after a prostate operation, on August 16, 1933.

Few men started their practice with the advantages that Harvey Mudd had, and few careers have fulfilled the promises of their auspicious beginnings better than did his. Under the fortunate aegis of his family tradition, and endowed with a physique that made it possible to labor endlessly, his alert acquisitive mind gathered knowledge and experience, and his fine personality made him sought for and developed in his patients a devotion that was an adulation. His spirit was that of a youth; it never grew old. He enjoyed people, if they were his friends, with a zest that is rarely equaled, and it is easy to understand why since his death one man wrote, "He was a wonderful man, full of human sympathy and loved by more people than any other man in St. Louis."

He was passionately fond of the outdoors, taking part in hunting expeditions with the keenest zest. His love for the country urged him to get a small place in the foothills of the Ozarks where he could raise turkeys and guinea fowls and some wild birds, a bird sanctuary in fact, and here he spent much of his spare time in the last few years. He had a great fondness for music and in his later years was a regular attendant at the symphony concerts, though he equally enjoyed the less classical forms of music. At his own home he was seen at his best, an ideal husband, parent and friend, always seeking to advance the pleasure of those dear to him, and his fund of good stories, always kindly, made him welcome and spread sunshine wherever he went. As President Williams of Missouri University wrote, "He was a credit to his City, his State, and to his Country."

M. B. CLOPTON.

GEORGE DAVID STEWART

1862-1933

GEORGE DAVID STEWART was born December 28, 1862, in Cumberland County, Nova Scotia, of Scottish descent. He brought traditions from both these sources to this country, where he began his medical education in 1886

GEORGE DAVID STEWART, M.D.

at the Bellevue Medical College, now the Medical Department of New York University, from which he was graduated in 1889. It was in connection with this college that he expended the greater part of his abundant energy and

industry during the remaining forty-four years of his life. He still held the position of Professor of Surgery, to which he was appointed in 1914, at the time of his death March 9, 1933. He became a Fellow of the American Surgical Association in 1915.

Stewart's greatest contribution to surgery was as a clinical teacher. He had, to an unusual degree, the power of clear and forceful expression so that the weekly operative clinics which he held in the amphitheatre at Bellevue Hospital for nearly thirty years were enthusiastically attended by his students, as well as by large numbers of visitors to the hospital.

His devotion to teaching and his real ability as an organizer of a surgical department along practical lines resulted, in 1930, in the creation of the amply endowed George David Stewart Chair of Surgery at his Alma Mater by a life-long friend, the late Mr. George F. Baker.

Doctor Stewart was a firm believer in the modified form of didactic teaching and under his leadership and influence such teaching had great value. The utilization of a municipal hospital for teaching purposes with university ideas is always fraught with administrative difficulties. In coöperation with the late Dr. William M. Polk, Dean of Cornell University Medical College, and Dr. Samuel Lambert, Dean of the College of Physicians and Surgeons, in developing Bellevue Hospital along these lines, Doctor Stewart illustrated one of his strongest characteristics—an ability to gain public confidence and turn it to public advantage.

He received the unusual honor of being elected for three successive terms to the Presidency of the New York Academy of Medicine. During his tenure of office, from 1919 to 1925, he carried forward developments in building and administration which placed that Institution in a position of leadership not only in this community but throughout the state and, to some extent, the country. His influence certainly was national. In 1927 he was elected President of the American College of Surgeons, which office he administered with great ability. His writings on surgical subjects in the clinical field were frequent and were characterized by a clear-cut manner of expression which placed emphasis where needed.

No sketch of the life of George Stewart would be adequate that did not include a reference to his love of literature, particularly poetry, and to other forms of art. He was a constant reader of the classics and, being endowed with an excellent memory, he delighted many audiences with apt quotations and anecdotes. He was a writer of verse of no mean merit. His ability as a speaker was widely recognized so that he was in constant demand on serious occasions and others less serious.

The Academy of Medicine, in mourning his death, bore testimony to the loss of a "forceful leader and teacher; a wise counselor; a kindly man and a dear friend. With his magnetic personality; his rare gift of humorous expression and his wisdom acquired through wide experience, he was a dominant figure among his fellows."

JOHN A. HARTWELL

JOHN SPEESE

1880–1933

THE Philadelphia Academy of Surgery has seldom been called upon to record the loss of its President during his term of office. Doctor Speese had several months still to serve when October 15 he died suddenly. He was a victim of coronary sclerosis—the "doctors' disease"—entirely unsuspected

JOHN SPEESE, M.D.

until his first attack a few weeks before. Only fifty-four, he seemed in full vigor and entitled to expect many years of work and reward. He was always a hard worker, never taking long vacations. The last year had been a particularly difficult one for him, bringing with it much hard work and an unusual degree of worry and strain. These factors were probably responsible for the acute development of his fatal disease.

Doctor Speese trained himself wisely, combining laboratory and clinical work in proportions that made him a well-rounded surgeon. As a result, his judgment in gross and microscopic tumor diagnosis was greatly sought after and valued. He was an excellent and safe operator, bold if need be, never rash. He understood the art as well as the science of surgery and his patients profited thereby. He was a helpful consultant; he had an analytical mind, quickly reaching the heart of the problem. His advice was sound, constructive and clearly expressed.

Well prepared by such experience, he was one of the many surgeons of America who offered their services to their country in the World War. Owing to changed needs, his unit was broken up soon after landing in France. Uncomplainingly he accepted unimportant assignments until he was made head of an operating team with Mobile Hospital 2. After an arduous term of service there, he was transferred to Mobile Hospital 8 as Chief Surgeon. Here his worth as surgeon, executive and man was widely appreciated. Returning home, he was one of those who rapidly came to the front, being rewarded by important hospital positions and memberships in national societies. He contributed articles to current literature and monographs to other publications.

From an experience of nearly thirty years in many places and relationships, the writer wishes to pay a tribute to Doctor Speese as a friend. He enjoyed companionship, he was a good mixer, he had a keen sense of humor and a faculty for analyzing people and things and summing them up in a pithy remark. These and other qualities made him a welcome member of many a circle.

EDWARD B. HODGE

EDITORIAL ADDRESS

The office of the Editor of the Annals of Surgery is located at 386 Park Street, Upper Montclair, New Jersey. All contributions for publication, Books for Review, and Exchanges should be sent to this address.

Remittances for Subscriptions and Advertising and all business communications should be addressed to the

ANNALS OF SURGERY
227-231 South Sixth Street
Philadelphia, Penna.